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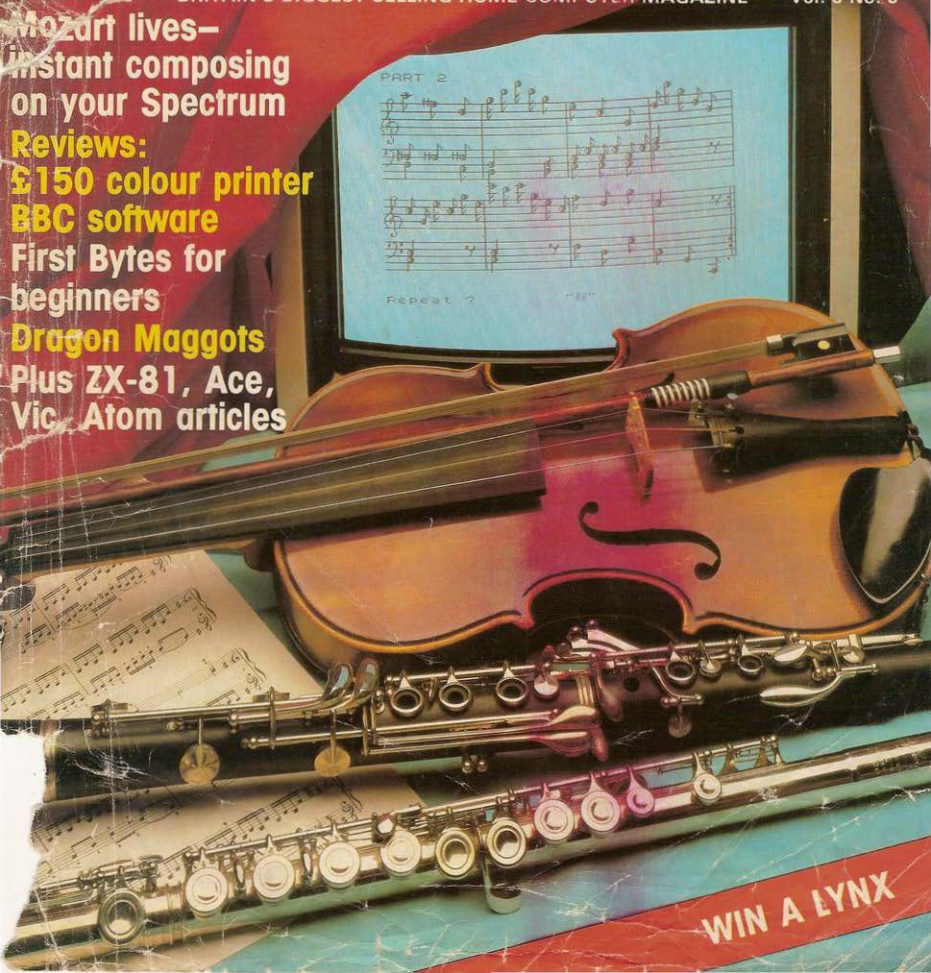

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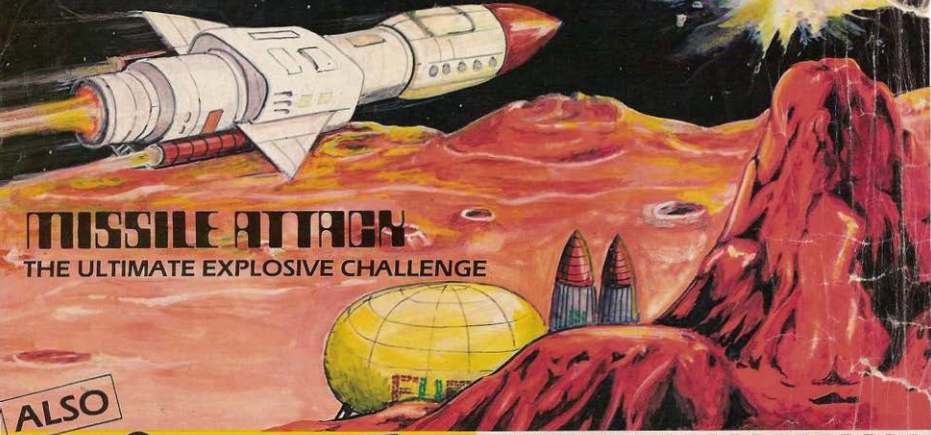

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YOUR COMPUTER Contents

MARCH 1983

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Vic Boogie — page 81. Below, BBC software: page 50.

Cover photograph by Stephen Oliver.

28 **EDITORIAL AND YOUR LETTERS:** 28 days that shook the Spectrum now shake Oric; breaking into schizophrenia; and our cynical view of advertising claims.

30 **NEWS:** £100 colour computer from Creativision; Texas £75 16-bit micro; losing a job and winning a place in our Top 20; Firth's first BBC Forth; Tomy's £160 Grandstand.

33 **NEWS EXTRA U.S.A.:** New micros galore. Intellivision gets brighter while a new age dawns for Mattel with Aquarius — the only £130 colour micro with plug-in Flintstones.

37 **COMPUTER CLUB:** Simon Beesley — our man in the bearskin and snow-shoes — discovers a lost tribe of Nascom owners alive and well and living in the West Midlands.

38 **FIRST BYTES:** If you have not passed Go with your brand-new micro go straight to First Bytes to collect an introduction to microcomputing and perhaps win £15 of software.

40 **ORIC V. SPECTRUM: THE SHOOT-OUT:** Sinclair was bang on target with the Spectrum last year but will the town be big enough for both now Oric is here?

44 **£150 COLOUR PRINTER:** Kathleen Peel reviews Tandy's CGP-115 four-colour printer which will plug into any computer with an RS-232 or Centronics interface.

50 **BBC SOFTWARE SURVEY:** Blast your way out of the arcades with Rocket Raid or just calm down and admire the economy of a word processor on a chip.

54 **MOZART LIVES:** Not only the first program to bring Wolfgang Amadeus back to life but also a hardware add-on which can make your Spectrum sound less like a damp squib.

64 **DRAGON MAGGOTS:** Percy's performing Maggots will have them writhing in the aisles in this brilliantly simple game of lightning reflexes for the Dragon 32.

68 **ACE FOR GAMES: FORTH PAC-MAN:** Forth is not just for high-speed calculations as Ralph Hilton shows with this arcade game for the Jupiter Ace.

70 **INCREDIBLE SHRINKING COMPUTERS:** John Dawson sums up 35 years of computer technology — from making noises in troughs of mercury, to silicon chips.

75 **ZX-81 MACHINE-CODE EDITOR:** Trevor Hill presents a user-friendly yet truly comprehensive monitor for the Sinclair ZX-81.

81 **VIC-20 POLYPHONIC BOOGIE:** Adam Macielinski squeezes a honky-tonk piano complete with graphics into the 3.5K of an unexpanded Vic.

84 **SPECTRUM WORD PROCESSOR:** A complete machine-code word processor for the Spectrum by Stuart Nicholls which even lets you create your own type founts.

90 **BBC MONITOR:** Space is of the essence in the BBC and Richard Harris has managed to fit a commercial-quality monitor into just 2K including a full disassembler.

97 **BBC ASSEMBLER:** The BBC Micro has the advantage of a built-in assembler but few people know how to take full advantage of it. Chris Melville advises.

100 **LANGUAGE LEARNING ON THE ZX-81 AND DRAGON:** The Brains show how you can use a micro to help you with French — or even Welsh — homework.

107 **ATOM ERROR:** When your desk-top Dalek starts screaming "Error" at you do not panic — just change the error messages to something more helpful.

111 **BASIC DICTIONARY:** Tony Edwards takes us from Proc to Tab as he nears the end of his marathon voyage through the Basic lexicon.

113 **RESPONSE FRAME:** Tim Hartnell tells you how you can differentiate 16K from 48K Spectrums, gives scrolling tips and tells you how to deal with large ginger cats.

115 **FINGERTIPS: POCKET COMPUTERS AND CALCULATORS:** David Pringle with another selection of programs to fit your pocket.

121 **SOFTWARE FILE:** 10 program-packed pages full of games, tips, and serious applications for the Ace, Atom, ZX-81, BBC, Vic-20, Dragon, Atari and Spectrum.

139 **COMPETITION CORNER:** Another exploding puzzle — Telepathic Dangers: a winner for the Oric competition and the result of the Star Stone teaser.

WIN A LYNX Just complete the crossword and think of a slogan to win this 48K colour computer — card between pages 26 and 27.

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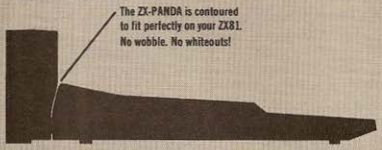

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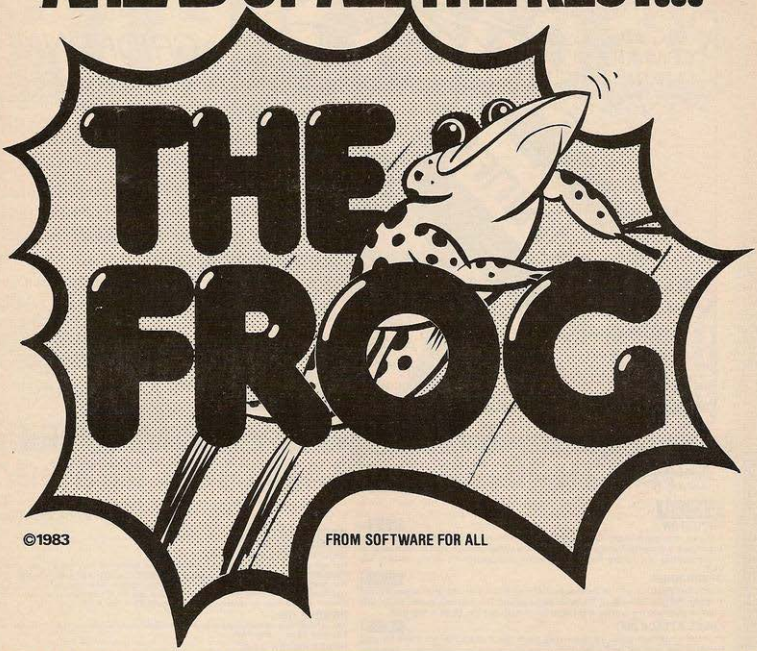

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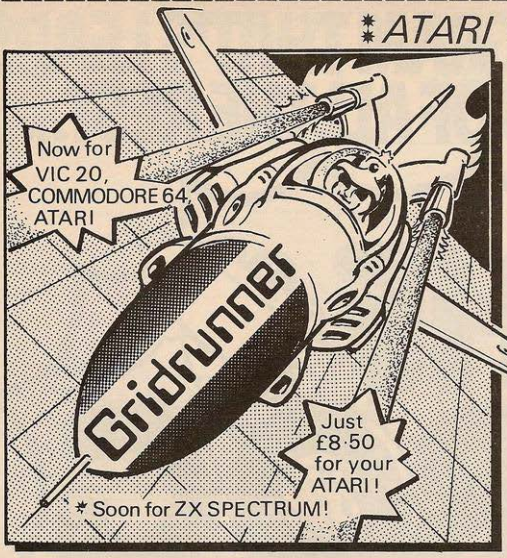

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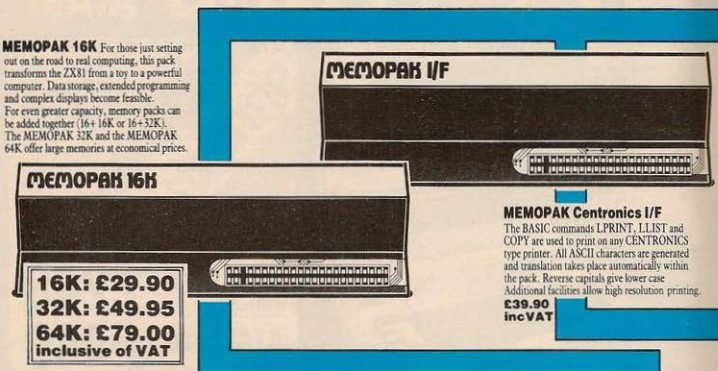

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The BASIC commands LPRINT, LLIST and COPY are used to print on any CENTRONICS type printer. All ASCII characters are generated and translation takes place automatically within the pack. Reverse capitals give lower case Additional facilities allow high resolution printing.
£39.90 inc VAT

It all adds up to an efficient, modular computer system

The **Memotech** approach to microcomputing is to take the well-proven and popular ZX81 as the heart of a modular system. This small computer houses the powerful Z80A processing unit and acts as the central processor module through which the **Memopaks** operate.

Memotech has a reputation for professional quality, producing units which are designed to fit perfectly, to look well-balanced, and to work efficiently and reliably.

The modular approach gives ZX81 owners the freedom to design the system they really need. Furthermore, the intercompatibility of the modules ensures that later additions will click straight in, to give you a system that grows with your ambitions and abilities.

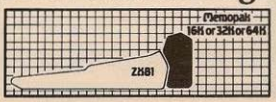
To ensure that your expectations are realised, care is taken at every stage to design features into the system to anticipate your needs. For example:
1) Memories are cumulative e.g. 16K and 32K can be added to the **Memopak 16K** or even to the Sinclair 16K RAM pack. 2) The **HRG** firmware allows commonly used constructions (such as scrolling, shading and labelling graphs), to be called by a few simple commands. 3) The **Centronics I/F** converts ZX81 character codes into ASCII and extends the print line to the width of the printer, still using the LLIST, LPRINT and COPY commands.

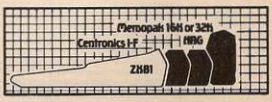
As one example, a system with 16K of memory and **Memocalc** is all that is required to perform the same sophisticated numerical projections as a computer at 10 times the price. The problem may be as complicated as a cash flow or production schedule, or as simple as household accounts or pocket money budgeting. If your bank manager wants to see a cash flow, then a single print instruction to the **Centronics I/F** will give a printout which is more than acceptable.

The example system which is shown, on the other hand, would satisfy the needs of someone who wanted to enter data

How it all fits together

You can see from the diagrams how various Memotech/Sinclair units can be combined.





otech,
tial of your ZX81...

MEMOPAK HRG This pack breaks down the constraints imposed by operating at the ZX81 character level and allows high definition displays to be generated. All 248 × 192 individual pixels can be controlled using simple commands, and the built in software enables the user to work interactively at the dot, line, character, block and page levels. Scrolling, flashing and animation are all here.

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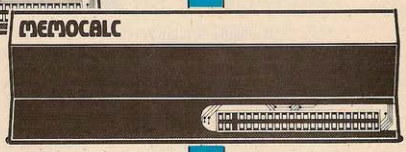

MEMOCALC The screen display behaves as a 'window' on a large sheet of paper on which a table of numbers is laid out. The maximum size of the table is determined by the memory capacity, and with a MEMOPAK 64K a table of up to 7000 numbers with up to 250 rows or 99 columns can be specified. Each location in the table can be either a number which is keyed in or a formula which generates a number.

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MEMOTECH KEYBOARD

The Memotech plug-in Keyboard plus buffer pack takes the effort out of data entry for ZX81 users. The Keyboard has a light professional touch and is housed in an elegant aluminium case. The simple plug-in system means that you are not obliged to open up your ZX81, use a soldering iron or invalidate your ZX81 warranty.

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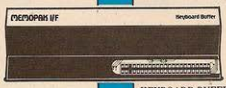

KEYBOARD BUFFER PAK
The Buffer Pak performs a "housekeeping" function for the Keyboard, interfacing directly with the port at the back of your ZX81.

via a light-touch keyboard, construct and label graphs, and then copy the screen to an 80-column printer. Only 16K of memory is shown here but with additional memory, more than one video page can be stored. Up to 7 pages can be displayed in rapid succession to give animated displays.

Looking forward, **Memotech** will continue to back the ZX81 through 1983 with fast storage devices, pressure sensitive electronic drawing boards and more software packs including a **Wordprocessor,** an **RS232 Interface** and a **Z80 Assembler.**

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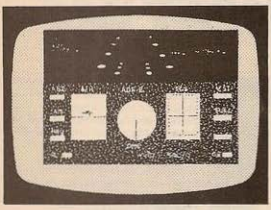

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A/H – artificial horizon
ALT – altitude in ft
HDG – heading in compass degrees
FL – flaps up/down
GR – gear up/down
VSI – vertical speed indicator
WIND – wind direction/velocity
DME – distance measure equipment
ADF – automatic direction finder
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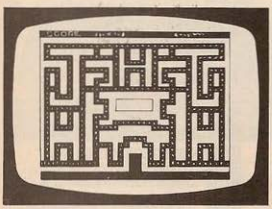

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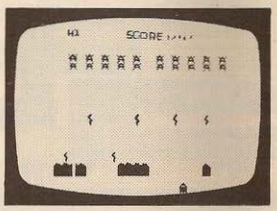

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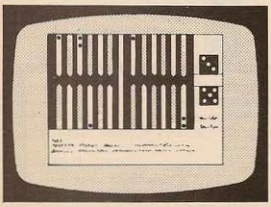

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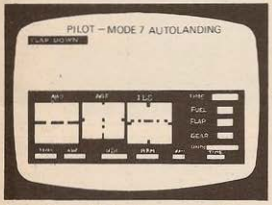

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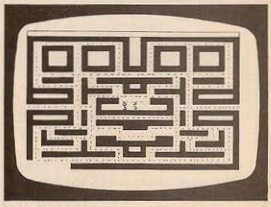

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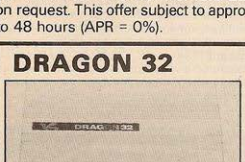

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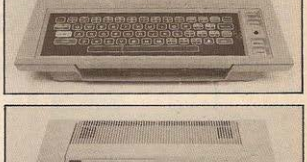

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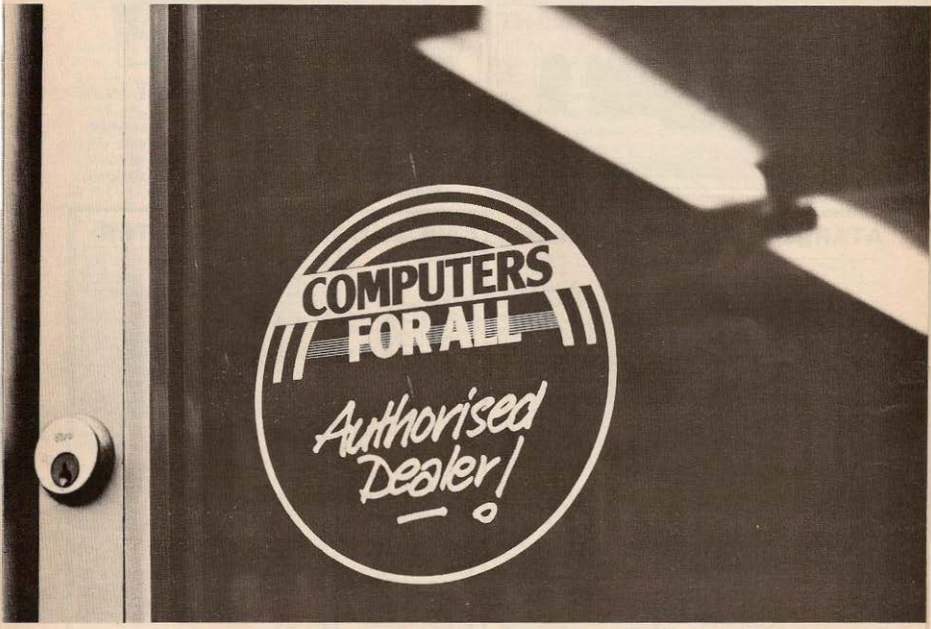

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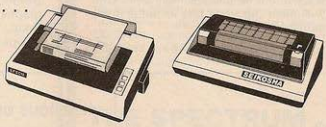

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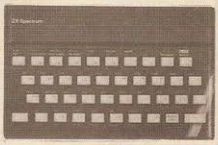

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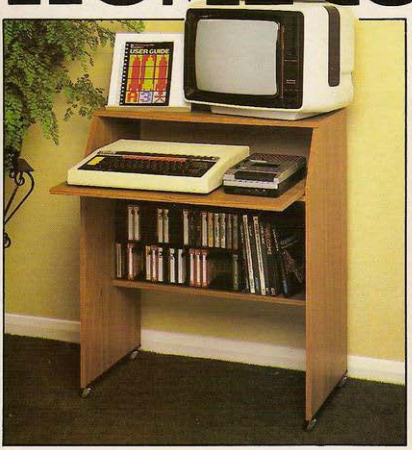

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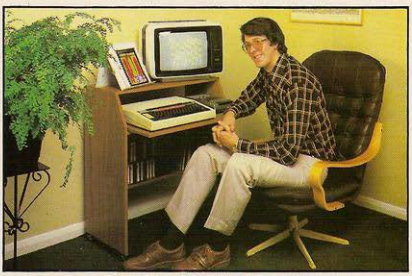

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Three out of every four computers going into schools are BBC Micros. Is there a lesson to be learned by every user?

As part of the current government subsidised scheme aimed at introducing micros to schools, the Department of Industry undertook a survey of machines available and made recommendations to education authorities all over the country.

The BBC Micro met their priorities exactly: it is economical yet fast and powerful, and it can justify the investment involved, through its capability to grow with the needs of the user and with the rapid changes in technology.

Teachers and education authorities agreed, and today it represents over three-quarters of all micros being ordered for schools across the country under the DOI scheme.

The BBC's choice too.

In choosing a machine to put their name to for their massive Computer Literacy Project, the BBC had the same set of priorities as the DOI. The BBC Micro is now an integral part of that project, which includes books, software, courses and a number of major television series, one of which, "Making the Most of the Micro" is now being broadcast.

All this for only £399.

The BBC Micro is light and compact. It generates high resolution colour graphics, and is capable of synthesising music and speech using its own internal speaker. The keyboard uses a conventional layout and typewriter feel.

The most sophisticated version (called Model B) is available for only £399. (There is also a basic model available, the Model A, at £299.)

Designed to grow.

Last year the magazine "Which Micro?" said that the most attractive and exciting feature of the BBC Microcomputer was its 'enormous potential for expansion'.

This is indeed one of the features that sets it aside from the competition.

For example, as well as interface sockets to allow you to connect to a cassette recorder, and to your own television, you can also use video monitors, disc drives, printers (dot matrix and daisy wheel) and paddles for games or laboratory use.

You can also plug in ROM cartridges containing games with specialist application programs.

The Tube. A unique feature.

The Tube, which is unique to the BBC Micro, provides for the addition of a second processor via a high speed data channel. The possibilities are enormous. For example, the addition of a second

3MHz 6502 processor with 64K of RAM doubles processing speed. While a Z80 with 64K of RAM opens the door to a fully CP/M* compatible operating system, with all the benefits for business applications.

Linking up with other computers.

The BBC Micro also offers a facility of immense potential value to schools, colleges and businesses. It's called Econet® – a system which uses telephone cable to link with other BBC Micros. A number of machines can then share the use of expensive disc drive and printer facilities.

Make full use of Prestel & Teletext.

With special adaptors you will not only be able to turn your TV set into a Prestel terminal and Teletext receiver, but you can also take data and programs direct from these services. (The programs, which are known as telesoftware, are already being broadcast by BBC's Ceefax service.) This is another first for the BBC Micro.

BASIC plus.

A sophisticated version of BASIC has been chosen for the BBC Micro, which incorporates features normally found only in more advanced high level languages. However, there is also a facility allowing access through a simple command to another language – for example, PASCAL, FORTH and LISP.

*Trademark of Digital Research.

A full range of software.

Applications software for the BBC Micro already cover a very wide field. Packages covering games, education and business applications are available on cassette. All developed to the same high standards set by the hardware.

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Your BBC Micro comes with the backing of the BBC and an extensive dealer and service network.

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2MHz 6502A Processor.
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How to buy your BBC Micro.

If you are a credit card holder and would like to buy a BBC Micro B, or if you would like the address of your nearest stockist, just phone 01-200 0200.

Alternatively, you can buy a Model B directly by sending off the order form below to: BBC Microcomputers, c/o Vector Marketing, Denington Estate, Wellingborough, Northants, NN8 2RL.

All orders are despatched by fully insured courier and come complete with easy to follow 500 page User Guide and Welcome cassette.

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Advanced space games, including the sophisticated 'Omega Race'.

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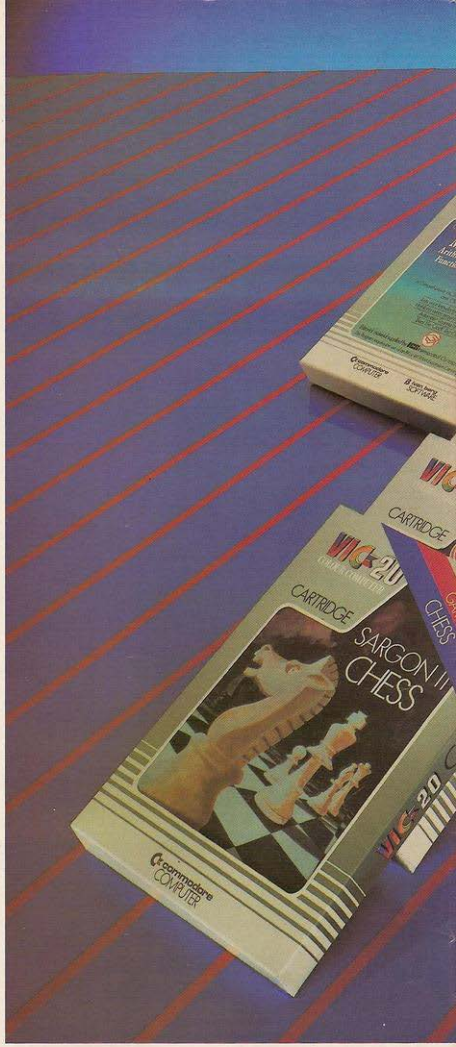
In addition, there is a range of VIC software, like programmers' aids and graphics packages – to add to your understanding and enjoyment of computers and computing.

There's even a special 'VicSoft' Club for VIC 20 enthusiasts, with many advantages including special offers to club members.



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For the best hardware, the best software.

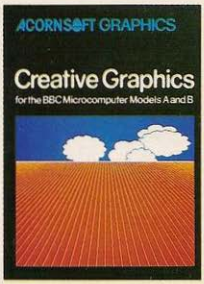
The BBC Microcomputer system is generally regarded to be the best micro in its price range you can lay your hands on. So, if you're thinking of buying one or already own one, you'll want to know about the software that's been specially designed for it.

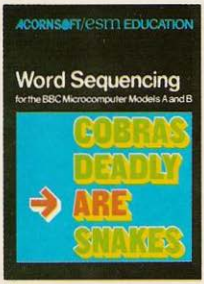
Not surprisingly, it's made by Acornsoft, the software division of Acorn Computers Ltd., who designed and built the BBC Microcomputer. So naturally you can expect the highest quality software with the built-in ingenuity to fully exploit the BBC Micro's potential.

Further education for everyone.

Creative Graphics, which includes the book 'Creative Graphics on the BBC Microcomputer' (price £17.45), provides 36 programs on cassette producing a spectacular range of pictures and patterns in full colour, including animated pictures, recursively-defined curves and three dimensional shapes.

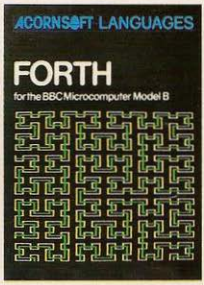
Word Sequencing (price £11.90) contains three word sequencing programs on cassette. Each program presents a series of jumbled words which must be arranged on screen to form either a proverb, nursery rhyme title or a sensible sentence.





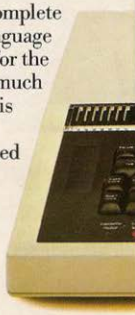
Learn more languages.

LISP (price £24.35) is the fundamental language of artificial intelligence research.



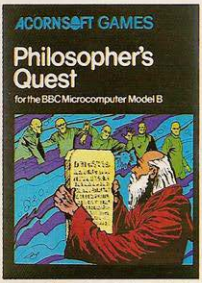
It consists of 5.5K of machine code interpreter, plus 3K of initialised LISP work-space containing utilities and constants. It comes complete with a book that introduces you to programming in LISP, as well as some fascinating applications.

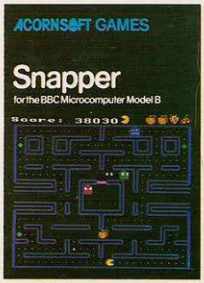
FORTH (price £24.35) is a complete implementation of the FORTH language to the 1979 standard specification for the BBC Microcomputer Model B. This much acclaimed programming language is also accompanied by a specially written book explaining all you need to know.

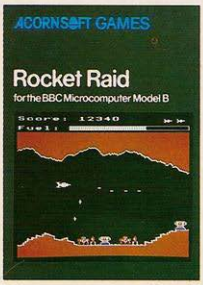


Mind-boggling games.

Philosopher's Quest (price £9.95) is an advanced adventure in which you tell the computer what you want to do and it







describes back in plain English your progress through a fascinating world of fiendish puzzles to be solved.

Snapper (price £9.95) is a colourful game where you guide your 'snapper' through the maze, eating dots and fruit and avoiding the creatures that chase you. Complete with full sound effects, score and a ladder of high scores.

Rocket Raid (price £9.95) sends you on a mission to raid a heavily guarded Martian fuel depot. You must fly your rocket over mountains and through caverns, avoiding enemy missiles and dodging convoys of deadly fizzers.

Increase your business acumen.

Desk Diary (price £9.95) is an indispensable program that can hold a file of several hundred names, addresses and telephone numbers.

And View, a program that enables your machine, together with a printer, to operate as a fully operational word processor. (The program is in ROM, but can easily be fitted to most BBC Micros by your local dealer.) You can find out more by sending for our free catalogue.

How to get Acornsoft programs.

If you're a credit card holder and would like to buy cassettes of the programs shown in this advertisement, or if you would like to know the address of your nearest stockist, just phone 01-200 0200.

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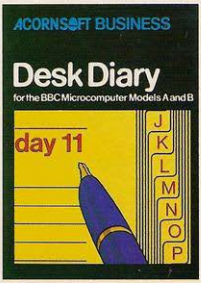
Please allow 28 days for delivery.



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Philosphers Quest	£9.95			(SBC01)
Snapper	£9.95			(SBC04)
Rocket Raid	£9.95			(SBC05)
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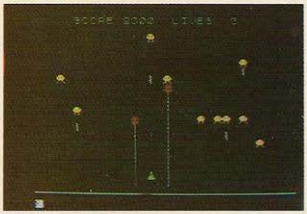
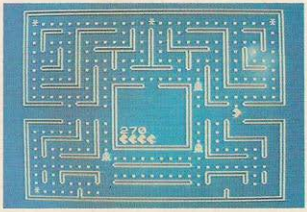


ZX Spectrum SOFTWARE

GORFIAN

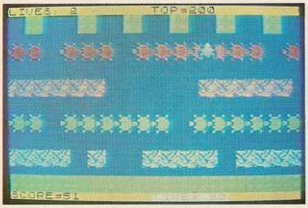
GORFIAN INVADERS, A Superb 4 screen machine code program with Invaders, Galaxians, Firebird and Flagship. Multicoloured Hi-Resolution graphics and Sound Effects.
For the 48K Spectrum, price £5.00



KRAZY KONG

KRAZY KONG, Another 100% machine code program, featuring 3 Screens of Hi-Res Gorilla, Barrels, Fireballs, Lifts and a Running and Jumping man who must rescue his girlfriend from the enraged KONG! For the Spectrum, price £5.00

SPECMAN & FROGGER



FROGGER AND SPECMAN, two excellent games for the price of one! SPECMAN is probably the best version of it's type with great machine code graphics and sound effects with 3 to 5 ghosts, power pills and a real munchie man who munches away in all directions unlike cheaper versions!
Frogger, is a 2 screen superb representation of this arcade classic and has full colour Hi-Res Frogs, Cars, Roads, Logs, Turtles and Riverbank. Plus Super sound effects.
Both on one cassette for the Spectrum, price £5.00.

CENTIPEDE

CENTIPEDE AND PAINTER
By the time you read this our latest release for the Spectrum should be available . . . . . .
Centipede is a full colour machine code arcade game where the object is to defend yourself with your Laser against a fast moving centipede which weeves in and out of the mushroom patch. There are other versions of this game but we think you'll prefer ours because we always strive for an extra dimension of realism, which makes all the difference!
Painter, is another well loved Arcade game here you must paint in between the numbers on a multicoloured screen before you have to overlap.
Price for SPECTRUM is £5.00.

HOW AND WHERE TO GET C☆Tech Software PRODUCTS
There are three ways to get the tape that you require, firstly you can go to one of around fifty retailers in the UK and some more overseas, there is at least one in every town and several in major cities.
Secondly you can ring our Telesales on 061-366 8223 and Alison or Shirley will take your order and tell you of any other games you might be interested in.
Last the most popular way is to simply clip the coupon and send it to us at:
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Vic Aid is a chip which slots easily into the DAMS RAM'N ROM Board, and offers two sets of Utilities in one for the keen programmer:

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VIC MON

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Another fine product to enhance the machine - code capabilities of the VIC, VICMON is the ultimate programming aid, incorporating: Assembler, Dissassembler, Fill, Re-Locate, Identify, Printing, Display Status Register, Display Memory with pause facility, Full Screen Assembly Edit, Software re-set from loops, Single step with variable speed etc. Slots into the DAMS RAM'N ROM board or similar.
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YOUR LETTERS

SCHIZOPHRENIA: DIVIDED VIEWS

I was rather surprised at the pompous and totally unhelpful reply to Bradd France in Response Frame in January's issue of *Your Computer*. Coming from a magazine that publishes advertising for a computer known not to be available for months on end, that is, the Spectrum, a high moral tone does not seem entirely appropriate.

What right has Tim Hartnell to assume that someone wanting to stop an auto-run machine-code program must be also wanting to contravene copyright? There have been a couple of occasions when I have unthinkingly made a machine-code program with a bug in it an auto-run version, and then Saved it to be safe. A lot of typing would have been avoided by having an ability to stop execution and rescue the item. Secondly I have found it a very valuable way of learning programming techniques in machine code. I do hope that Tim Hartnell is not proposing to have the copyright laws changed to make even study illegal.

If the user of a stopper program does in fact intend to infringe copyright, then what business is it of yours anyway? However, if you do feel that "it would be highly irresponsible to publish" a program intended to break into machine code then perhaps you would care to explain why you did publish one in the December Software File? Gino Gracin's very useful "list self starter" was just what Mr France needs, but as I imagine that your curiously-mixed morals will prevent you publishing this to let him know then I can only hope that he found it for himself.

While I am at it can I suggest that your contributor to Response Frame sticks to answering questions about computing — which he is evidently competent to deal with. I have in past issues seen some entertaining replies to TV and tape recorder queries.

A Jaques, Urmston, Manchester.

BUG SPOTTER

You only do it to annoy, because you know it teases! All those errors in published machine-code programs. Three recent corrections, which may be helpful to your other readers, are as follows: first, Hopper, January 1983, addresses 16854 to 7 were left out and should be 22 D3 40. 16974 should contain B3, and 16975,6 should read 20 FB.

Second, Snake, February 1983 Software File, addresses 16574 to 16581 omitted, putting all subsequent addresses out by eight bytes. These addresses should contain 01 12 13 11 01 00 18 16.

Third Maze Chase as listed, also February Software File, gives a set of bars but no maze. Address 16564 should contain 00. All the above codes are hexadecimal numbers. I know it is good for us to debug machine-code programs, but this can take longer than entering them.

J R G Nash, Botley, Oxfordshire.

RAM WRINKLE

When the BBC Basic conversion board is fitted to an Acorn Atom, it disables the Atom's bus buffers for addresses in the range 4000-7FFF. This is sensible when in BBC mode, as this area of memory is then used for I/O, the utility ROM, and the graphics RAM. But when in Atom Basic mode, this area could otherwise be used by external RAM to extend the text space.

Luckily, a simple modification to the BBC Basic conversion board will enable the bus buffers for this address range when in Atom mode. It involves bending pin 11 of IC14 up so that it no longer makes contact with the socket, then connecting this pin to pin 12 of IC 12.

Readers may also be interested to note that with the extra 2K bytes of RAM provided on the BBC Basic conversion board, the total RAM in the system becomes in the BBC mode:

8K from 0000 to 1FFF
6K (graphics) 4000 to 57FF
and in the Atom mode
1K from 0000 to 03FF
7K from 2000 to 3BFF
6K (graphics) 8000 to 97FF

Mike Lord, Basildon, Essex.

FAST SLIDE

Stewart Stallworthy obviously went to a great deal of trouble to prepare the Z-80 Slide Show code — Software File, January 1983. The essence of the job can be done with the single instruction LDir, and roughly three times faster, as follows:

Code	Assembly	Comment
21 A4 9C	LD HL,40100	first byte of saved display, the same as the published example.
11 00 40	LD DE,16384	first byte of display file proper
01 00 1B	LD BC,6912	byte count
ED B0		LDIR block transfer until BC = 0
C9	RET	

12 bytes of code, versus Stewart's 48, and relocatable! The whole thing really does operate with astonishing speed; it takes about six milliseconds to execute the whole routine once on my Spectrum. Try alternating between two Saved displays — it is enough to make your eyes water!

Incidentally, I detected a bug in Stewart's listing; address 40029 should contain 239, not 238 as shown. Fortunately it does not matter; the JR points to the last byte of LD HL,nn at 40010 which decodes as LD B,B.

D W Albery, Fleet, Hampshire.

BUZZING

ZX-81 users may be interested to know that one reason for loading problems may be the close proximity of TV set and tape recorder. Check by running the recorder on play without a cassette or with a blank tape and with the volume turned up high. When placed near a working TV set, particularly at either side, a harsh buzz will be heard. If a ZX-81 set to Load is then connected, a pattern of bright bands reminiscent of correct loading but closer and narrower will be seen even though no program is being played. Previous to this discovery I had to strike a balance between too little volume and too much. Too much volume was really interference from the scan coil in the TV. Now with a cassette player two to three feet distant, I can use full volume and get perfect loading.

A second discovery is that an edge connector with the trade mark UECL has a contact design which I consider gives much more positive contact with the ZX-81 circuit board. I have also carefully removed the thick layer of solder from the ZX-81 contacts. I can now deliberately rock my home-made memory board back and forth without losing memory; previously even a slight vibration could cause a maddening crash.

Could I suggest that computer reviews be aimed rather more towards the user like myself who has little interest in games. For example, a computer without Arc Sine and Arc Cos is an anachronism to me. Accuracy of working can be of interest since 8 figures is sometimes insufficient for one of my interests, astronomical calculations. A point which I have never seen mentioned is the resetting of variables — that is, data to zero — if a program line is altered. This is most frustrating when debugging a program, but with my ZX-81 I can go along happily editing and restarting at the corrected line.

B Manning, Stakenbridge, Worcestershire.

1K CHESS

The code presented for the three articles on chess is correct. If you are having problems then I'm afraid an incorrect number has been typed in and you are finding out first-hand the pleasures of machine-code programming.

I did omit to tell you of two Pokes prior to saving the 1K working game which provide the moved King or Queen's pawn. Prior to typing RAND USR 18542 type

POKE 17241,0
POKE 17262,63

These move the King's pawn forward then

RAND USR 18642

STRANGE DISSERTATION

Time is envisaged by some thinkers as particulate. That is to say, time is composed of discrete particles. These particles are known as chronons, and being particles they must have mass. Since they have mass it follows that they must occupy space.

The rate of flow of time is demonstrably the same in all parts of the universe — except when very high speeds are considered — so much is common knowledge.

I am convinced that this state of affairs does not apply to the space in the vicinity of microcomputers and their associated paraphernalia. My theory is that microcomputers interfere with the space-time continuum in such a way that the density per unit area of chronons in the vicinity of these objects is very much reduced: it can be seen that in a volume of space where there are few chronons, the amount or quantity of time will be less than in a normal volume of space.

A few minutes near a microcomputer may be equivalent to an hour or more in a normal atmosphere, so that when your wife/husband/girlfriend/boyfriend calls you away from your computer, and you reply, "five more minutes", is it surprising that an hour or more of normal time passes?

This theory also explains the 28 days phenomenon. For example, it is not widely known that Clive Sinclair is convinced that the whole world is playing an immense practical joke on him — he believes that all his computers were delivered within 28 days. What he is unaware of is that the 28 days were measured in the rarified chronon atmosphere surrounding his computer factory.

Dominic Purdue, North Jesmond, Newcastle-upon-Tyne.

and Save this on to tape or type:

```
POKE 17242,128
POKE 17253,53
```

moves Queen's pawn forward.

These Pokes move Queen's pawn forward then:

```
RAND USR 18542
```

and Save on to tape.

If you give up, but still would like the game, you can probably obtain a 1K chess by either Artic or Sinclair from your local supplier. If in difficulties write to me enclosing £3 and I will return a tape of the playing program.

David Horne,
Crowborough,
Sussex.

CREEPY LIFE

Some errors crept into my ZX-81 life program in the January 1983 issue of *Your Computer*. In the machine-code list, figure 1, the code at location 16603 should read 6,32. Also in the Basic listing, line 135 should read Goto 40.

P J Whittle,
Chobham,
Surrey.

ZX RAND

The Rand statement on the ZX-81 and the ZX Spectrum is very useful. It is used to call a lot of machine-code routines in the form:

```
20 RAND USR 16514
```

However, the Rand statement can be used for a lot more. When Rand is used; the number following the Rand statement is placed in locations 16434 and 16435 — see page 178 in the ZX-81 manual. On the XZ-81 these locations can be used to pass numbers to machine-code routines or for a quick conversion routine.

Suppose you wanted to Poke N into locations 16514 and 16515, normally the program

```
10 REM XX
20 INPUT N
30 POKE 16514,N-INT(N/256)*256
40 POKE 16515,INT(N/256)
```

would be used, using Rand the following could be:

```
10 REM XX
20 INPUT N
30 RAND N
40 POKE 16514,PEEK 16434
50 POKE 16515,PEEK 16435
```

This saves 13 bytes on the original and takes about half the time to execute. One word of warning. Having N=0 will not work as unpredictable results will be put into locations 16434 and 16435. The same technique can be used on the Spectrum but the locations that Randomise sets will need to be looked up.

Finally a four-line program to set RAMtop. The RAM size is held in N that is N=1 for 1K

```
10 RAND 1024*(16 + N)
20 POKE 16388,PEEK 16434
30 POKE 16389,PEEK 16435
40 NEW
```

Each line can be entered as a direct command.

Tim Griffith,
Coventry,
Warwickshire.

EDITORIAL

WHEN THE finely-worded comparison tables of the micro-makers trawl for new buyers, only the computing-wise slip through the net. They make sure that when they are eventually caught it is because they wanted to be: they know how to read between the lines. The rest of us swim blindly into those grids which compare the features offered by the new wonder micro with its competition. Naturally, only the advertised machine has a tick in every box.

Occasionally we may wonder about the importance of the green plastic securing screws which the table tells us only the touted micro can boast. But usually we swallow claims for speed, memory and resolution hook, line and sinker.

Of course, these claims are rarely untrue, but they are often only relative facts and depend largely on the knowledge of the would-be buyer for correct interpretation. You might not be hugely impressed by a car whose adverts major on the fact that it features a complete internal combustion engine. On the other hand, a total newcomer to computing might be awed by the promise of a silicon-wafer central processor.

Sometimes the glossy brochures can be unhelpfully obscure. Just how many beginners really needed to know that the ZX-81 offered a full 26 For-Next loops?

Against that, facts which are genuinely useful are frequently omitted. The amount of RAM remaining after the operating system and high-resolution graphics have helped themselves is the kind of information that can sway a buying decision.

This is because it is the type of fact that can reduce the 48K Lynx to an 11K machine, and the 32K BBC Micro to an 8K one. The £50 Microdrive promised in the Spectrum adverts seems to offer mass storage at a micro price, but for the last six months there has been no reference to the £30 interface you will need to drive it.

The modern buyer must also be a student of relativity to be able to understand the "high" in high resolution, the "low" in low cost, or the "fast" without which Basic would no longer seem complete.

Although "advanced" in the context of graphics presumably means user-defined, a smattering of semantics comes in handy when trying to decide what "professional" means when applied to a plastic-capped rubber keyboard. Descriptions of sound and colour facilities contain the same sort of ambiguities — ambiguous, at least, for the beginner. One of the solutions to these problems is increased computer literacy. With a buying public as well informed as in the car market, the home-computer manufacturers will be obliged to be even more precise in their publicity machinery. It will also mean that the buyer will recognise which features are common to all micros and which are specific to the one advertised. Being told that Basic is resident in ROM does not have quite the same glamour if you know that this is the rule rather than the exception.

After years of complaints about the misleading claims of motor companies for their cars' petrol consumption, legislation was needed before independently-assessed mileage figures were introduced.

Unless the industry can come up with a set of mutually acceptable standards by which micros can be judged, it may find similar measures forced upon it. ■

How to write for *Your Computer*

We called this magazine *Your Computer* precisely because we welcome your views, tips and hints and even your criticism of machines and software in general. If you would like to see your name in print, whether on a Software File program or a full-blooded article, here is how to go about it. Ideally, all articles should be typed double-spaced on one side only of uniform sheets of paper. If listings can be dumped directly from a printer — you can always use a friend's or user group's — this minimises the risk of error. In a perfect world a cassette would accompany the article. That considerably speeds up the checking process. Not only do you get to air your own discoveries and opinions, but we will even pay you for the privilege. We pay £35 per published page — that's as it appears in the magazine and includes illustrations.

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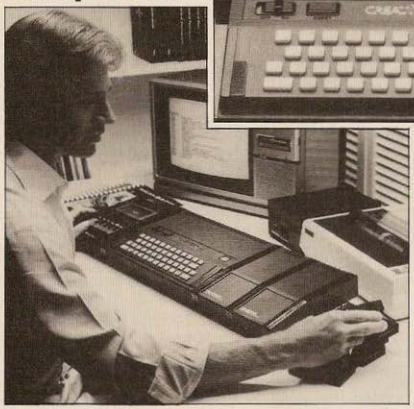
£99 Creativision is one up on rival computers



COLOUR, SOUND, and 16K for £99 is rapidly becoming an industry standard, but the Creativision goes one better — literally — it has 17K of RAM.

Although the standard Personal Computer unit looks more like a video game than a home micro, the unit contains a 6502 processor as found in the BBC Micro, the Vic and the Oric and is capable of being expanded to 64K RAM. Resolution is 256 by 192 with 16 colours three sound channels and a noise channel. The 12K ROM includes a Microsoft Basic.

The standard keyboard combines the idiosyncratic layout of the MZ-80K with the feel of a ZX-81 with the cunning innovation of a half-inch gap splitting the board in half so that the two joysticks can be lifted off the front panel.

The optional keyboard — illustrated — is at normal typewriter pitch but it still lacks a full-size spacebar. The screen display is 28 columns of 24 characters each composed from a five-by-seven fount.

A purpose-built cassette recorder, memory expansion units and Centronics and RS-232 interfaces can be plugged into the side of the standard unit. Every 16K of additional memory costs £39 as does each interface.

A Modem and a disc drive will also be available when the machine goes on sale in June, along with printers and acoustic couplers.

ROM cartridges will offer Extended Microsoft Basic and games ranging from old arcade standards such as Sonic Invader and Crazy Chicken to the intriguingly named Police Jump.

YOUR COMPUTER TOP 20

Game	Company	Machine
■ Hobbit	Melbourne House	Spectrum
■ Black Crystal	Carnell Software	ZX-81
■ Spectral Invaders	Bug Byte	Spectrum
■ Krazy Kong	Software City	Vic-20
■ Frogger	D J L Software	ZX-81
■ Moons of Jupiter	Romit	Vic-20
■ Orbiter	Silversoft	Spectrum
■ Martian Raiders	Audiogenic	Vic-20
■ Defender	Atari	Atari
■ Jelly Monsters	Commodore	Vic-20
■ Timegate	Quicksilva	Spectrum
■ Flight Simulation	Psion	ZX-81
■ Star Raiders	Atari	Atari
■ Ground Attack	Silversoft	Spectrum
■ Penetrator	Melbourne House	Spectrum
■ Gauntlet	Colourmatic	ZX-81
■ 3D Defender	J K Greye	ZX-81
■ Space Pirates	Bug Byte	BBC
■ Planetoids	Acornsoft	BBC
■ Hoppit	Commodore	Vic-20

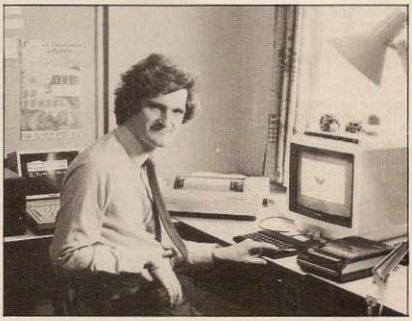
Forth of Firth first for BBC

R Q FORTH, written by Roger Q Firth for Level 9 Computing, is a Forth compiler for the BBC Micro. It fits into the model A's 16K, leaving space for about 200 lines of user program. Major features include a full screen editor, 260 predefined Forth words, and an unusual provision for using recursion.

Firth Forth programs run up to 10 times faster than BBC Basic — itself probably the fastest version of Basic on any home micro.

The compiler comes on cassette together with a 70-page manual and costs £15 inclusive. To go with it, Level 9 Computing supplies a Forth toolkit which adds a further 200 new functions and includes such utilities as a 6502 assembler, turtle graphics and five decompiler routines. This too is accompanied by a full manual and costs £10.

Light at the end of the Tunnel for Evans the Top 20 games writer



WITH MORE AND MORE of the sales of home computer games concentrated in the hands of a few large software companies it is unusual to find a highly successful company run by a staff of two. Malcolm Evans writes the programs for New Generation Software and, assisted by his wife, also handles production and marketing.

All his games have sold in large numbers and he has even had the distinction of having two hit programs in *Your Computer's* Top Twenty at the same time. 14,000 people have bought his Spectrum program, Escape, and his latest release, 3D Tunnel, looks set to have the same success; already WH Smith has ordered 10,000 copies of the game.

He wrote his programs for the ZX-81 — 3D Defender, 3D Monster Maze and Full Screen Breakout — for J K Greye Software. At the time he was employed by Sperry in Bristol as head of the Microprocessor Applications Group. When Sperry offered him the choice of moving elsewhere or redundancy he decided to strike out on his own with New Generation Software.

3D Tunnel took Malcolm Evans three months to complete. He developed the program on a Sharp MZ-80B before downloading the machine code into the Spectrum.

Like Escape, 3D Tunnel follows an original idea and is not just another version of an arcade favourite. The player has to pass through five stages, destroying bats, rats, toads and spiders before meeting the final obstacle, a London underground train. The game costs £5.95 and will run on both the 16K and 48K Spectrums.

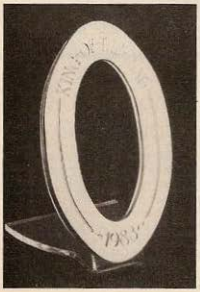
Texas TI-99/2: a new frontier

TEXAS INSTRUMENTS has now released details of the TI-99/2 described in last month's news item. It will be launched in September for around £75. The screen display is monochrome but with the same text format and pixel resolution as the TI-99/4A — that is, 24 by 32 and 192 by 256.

In addition Texas is introducing new low-cost peripherals and software for the TI-99/2 that will also work with the TI-99/4A. These will be on the market in May this year and include a four-colour printer/plotter for £150 and a £120 digital tape drive with a data transfer rate of 8,000 baud.

Most peripherals for the new system will plug into a Hex-bus, a peripheral interface connector, at the back of the machine. At the initial launch 20 programs will be available.

This £700 silver ring — the first prize along with £1500 worth of Acorn hardware and software in the Your Computer/*Acornsoft Castle of Riddles competition — is still looking for an owner. Early-birds received their cassettes in the post on the morning of February 16. Acornsoft's managing director claims that the Castle of Riddles adventure game is extremely difficult and that people entering the competition a few weeks after the opening date would probably still be in the running. A winner must be found by March 31.*



Tomy the toy-maker's 16-bit micro is not just a Japanese plaything

TOY TOWN has already moved into games machines and is now heading in to home computer land. Tomy, the Japanese toy manufacturer, is launching the 16-bit Grandstand Computer with 16K ROM and 16K RAM for around £170.

The standard machine offers only 19 Basic commands and its main strength lies in its graphics facilities. A built-in character generator allows the user to define a character on an eight-by-eight grid in the lower part of the screen and then position the character with the cursor in the main display.

16 colours are available in a resolution of 256 by 192. Up to four sprites can also be designed and moved by program commands or under joystick control.

Games cartridges can be plugged in and there is provision for further ROM cartridges to extend the Basic and to handle a printer and a floppy disc. The Grandstand Computer has a full 56-key keyboard and will be supplied with two games paddles.

Quicksilva fast to spot new software talent

QUICKSILVA IS AMAZED at the number of new programmers out there just waiting to be discovered. A series of advertisements for new talent drew such a good response that it was able to commission new programs for the whole range of home computers.

As a result new Vic and Atari games have now been released along with new titles for the Spectrum and ZX-81. Coming shortly are games for the Dragon, BBC Micro and Lynx.

Quicksilva has also taken on the marketing of the Pixel range of games for the Vic-20 and ZX-81. Production director, Mark Eyles, says that the company seems to be turning into more of a publishing house than a software company.

He added that Quicksilva felt that programmers were very important and should be given the same credit for their programs, in advertisements and on the packaging, as authors receive for their books. Enthusiasts who enjoy a particular program could then look out for the author's next release.

Quicksilva now has distributors all round the world. Mark Eyles jokes that if the company continues to expand at its present rate it would achieve multinational status and "we will all be tax exiles before long."

£49 Modem widens net

MICRONET 800, the Prestel database for personal computers, was technically opened on February 21. Networking interfaces are being offered to the first 10,000 subscribers for £49. These include all the hardware and software needed to link the computer up to Prestel via the public telephone system — an acoustic Modem, powerpack, cables and the necessary software.

Adaptors are now ready for the BBC, and Tandy Colour Computer with the necessary software supplied on tape or disc. The Spectrum and Dragon adaptors which should be released in March will be in the form of plug-in cartridges and contain the software in ROM.

The Spectrum Desk Console is designed to house a Spectrum and all its peripherals. There is room for a printer, a cassette recorder and the power unit as well as an RS-232 interface and up to two Microdrives. Made from heavy-gauge ABS plastic, it is available from Traffic Technology, PO Box 2, Warminster, Wiltshire, BA12 7QX, for £42.18 inclusive.

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SIGNATURE

Mattel's new age dawns with Aquarius — the 16-colour micro

AT LAST the big American games-machine makers have realised that people prefer to play games on proper computers that they can use for other purposes. Mattel — which makes the Intellivision — is no exception. Not only has the company now launched the Aquarius computer in the States — Britain will have to wait until September — but it has also launched an upgrade kit for the Intellivision.

At less than £100 the 4K, 16-colour Aquarius will be a strong rival to the Timex 2000 in America but the planned £120 British price tag will not frighten Sinclair or Oric. The rubber keyboard does not have a full-size spacebar but a keyboard overlay allows you to make use of a single-key entry option.

The British version will probably have three sound channels and the screen will have 320 by 192 resolution. The Z-80A based machine will run Microsoft Basic.

In America an extra £150 will buy you a tape recorder, thermal printer, joysticks and an expander. A similar package will be available here though the price will be higher.

A built-in RS-232 should encourage Aquarius buyers to consider the Modems and floppy disc drives which Mattel will also be supplying. Mattel claims that the Aquarius will be able to run CP/M.

Meanwhile, anyone who thinks their Intellivision is not too bright will welcome the Intellivision Computer Adaptor. This plug-in keyboard also boosts the machine's memory by 2K and makes Microsoft Extended Basic available along with a six-channel sound generator. The price will be around £80. An £80 piano-style 49-key keyboard incorporating a synthesiser also plugs into the adaptor.

Both the Aquarius and the brighter Intellivisions will be able to run a Logo cartridge, a Basic teaching package, and games based on Scooby-Doo and the Flintstones.

Texas boldly goes to school

COMPUTER literacy is big business in the United States and the new Texas TI-99/2 is aimed squarely at this market. No colour, no sound, but a 16-bit computer whose programs and peripherals are compatible with the established TI-99/4A.

It comes with 4.2K of RAM and 24K ROM and is available in the States for around £60 — for U.K. details see page 31. Expandable to 32K RAM with a rubber keyboard and full-sized spacebar, this is a very real competitor to the American ZX-81, the Timex 1000.

Japan's JR steps in for Panasonic and NEC launches PC-6001

THE JAPANESE have entered the U.S. micro arena. Panasonic's £150 machine boasts 32K of RAM and 16K of ROM, with 2K separate video RAM and 2K character RAM. It has a full-size spacebar and separate cursor control keys. The CPU is a Panasonic chip — the MN-1800A — which is equivalent to the 6802, not a chip that many will be familiar with.

The JR-2000U, which employs its own brand of Microsoft-type Basic, has a choice of eight colours, RGB and TV outputs. Where Panasonic's new baby may be at a disadvantage is in its relatively low resolution of 64 by 48 in the graphics mode.

NEC has also launched its PC-6001 which sells for around £200. It has a rubber keyboard, 16K RAM, 16K ROM, and can be expanded up to 48K. Nine colours are usable and text and graphics can be freely mixed.

Low U.S. price for Spectrum

THE TIMEX Sinclair 2000 — alias the American Spectrum — sells over there at around £95 for the 16K version and £125 for 48K. Air vents on the back, a different ROM, a three-voice sound chip and provision for two joysticks are new features, plus a more rugged printer. Do the U.S. prices hint at future U.K. prices?

Spectra Video's new micro — below — costs around £250 and claims to be CP/M compatible. It has 32K RAM and 32K ROM, offers 16 colours, sprite graphics and pixel-addressable colour. RAM can be expanded to 144K ROM to 96K. It has rubber keys, full spacebar and a joystick on the console.

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Computer Club is here to encourage you to start your own local computer club or, if one already exists, to join it and become involved. We would like to hear of anything which has made your club a success, or of any projects or programs you are developing.

Simon Beesley encounters the micro generation gap and a naked Nascom at the West Midlands Amateur Computer Club.

Nostalgia versus the new microcomputers

A NEWCOMER TO computing who wandered into one of the West Midlands Amateur Computer Club meetings would probably be struck by the number of machines present which have long since been out of the spotlight. In this respect the West Midlands Club is typical of most computer clubs of several years' standing.

Until recently the Nascom and other kit-based computers such as the UK101 held sway in computer clubland. Although the Nascom was, and is still, available ready-assembled, most owners preferred to build it up from a kit. In the process they needed to develop a greater level of hardware and software expertise than is required if you buy, say, a Vic across the counter. The Nascom is designed for expansion and dedicated owners often end up running CP/M and twin disc drives on their machine.

When the ZX-80 appeared, as the Model T of home computing it introduced a new type of enthusiast to computer clubs. Whereas the kit builder had to be prepared to wield a soldering iron, a Vic or Spectrum owner is unlikely to want to dabble inside the machine.

A fully-fledged Nascom, circuit boards and wiring exposed to view, can be an unnerving sight to the owner of a sealed and packaged mass-produced micro. Many of the new members at computer clubs are now more interested in software than hardware and particularly in games.

Both camps are well represented at the WMACC. The club has been running for five years and has over 150 members. These include 40 Nascom owners as well as a host of Vic, Spectrum and ZX-81 owners. A further 35 members own Pets. As treasurer Malcolm Sparrow explained, the club rarely organises talks or demonstrations but prefers to let members follow their own pursuits.

Naturally interests and activities are diverse. Chris Kitson moved from Nascoms 1 and 2 to a Gemini board. He has written programs to display fast-moving three-dimensional perspective views at 512 by 512 resolution by linking the Gemini up with a graphics-display processor.

In common with most clubs many of the members are interested in exchanging and copying programs. One of the hazards of visiting computer clubs for a magazine is that the visitor is confronted with the magazine's readers. David Hardwick made a vehement but good-humoured attack on computer magazines in general for publishing error-ridden listings. He appeared to be pacified however by the news that *Your Computer* is setting up an even more rigorous checking procedure.

The club meets twice a month on the second and fourth Tuesdays at Elmfield School, Love Lane, Stourbridge. Full membership costs £4 a year and as an unusual facility, members are offered cheap insurance rates on equipment brought along to meetings.

Local society news

London Computer Fair

THE ASSOCIATION of London Computer Clubs promises fun for all the family at its 4th London Computer Fair on April 14-16. After three years at the North London Polytechnic, the Fair has now moved to Central Hall Westminster. The admission fee is £1.50 for adults and 75p for children. Bargain hunters should attend the bring-and-buy sale held on Saturday only.

Gravesend computing

GRAVESEND Computer Club meets on the first and third Tuesday of every month at 7.30pm in the School Room of the Extra Tuition Centre, 39 The Terrace, Gravesend. Kent. For more details ring Steve Janday on 0474-50677.

BBCs in Wales

WALES, first BBC Microcomputer club has been formed in Cardiff. Meetings are held on alternate Wednesdays in the Applied Science Lecture Theatre of University College, Newport Road, Cardiff. Available facilities include four 24in. elevated monitors and full audio-visual equipment. The club has more than 60 members and also runs a Beginner's Corner. Further information from Geoff Barker on Penarth 701023.

The New Mills boom

IN JUST three months the New Mills and District Personal Computer Club has outgrown its existing premises at the New Mills Youth Centre and now meets at New Mills school on the fourth Monday of the month. Members' machines include most makes of home computer. Games enthusiasts are well catered for and competitions are held to develop programming skills. Further details from John Eary on New Mills 43870. ■

FIRST BYTES

Starting out in home computing? First Bytes is for you. Just write to *Your Computer* with any hardware or software problems, no matter how small or simple.

QUESTIONS

What is machine code?

'Can you tell me the difference between machine code, assembly language and Basic?'

AT THE HEART of every microcomputer is a microprocessor, which is really a computer inside the computer. The only language the microprocessor understands is machine code instructions. Each instruction takes up one byte — a set of eight bits of ones or zeros. Since a machine-code program just consists of a list of numbers, writing a program in machine code itself is tedious.

Assemblers are designed to make the programmer's task easier by allowing you to enter mnemonics rather than the numbers themselves. A mnemonic both stands for a machine code instruction and serves to indicate what it does. For example the code 248 in 6502 machine code tells the processor to increase one of its storage locations, the Y register, by one; the mnemonic for this in assembly language is INY.

Disassemblers convert machine code to mnemonics and can be used if you want to examine a machine code program already in the computer.

Whereas assembly and machine code are low level languages Basic is a high level language and needs to be converted to machine code by a Basic interpreter or compiler. Most micros use an interpreter which is itself an 8 or 16K machine code program usually in ROM. When a Basic program is run the interpreter translates each Basic statement to the equivalent machine code instructions.

Converting Basic to machine code line by line is both inefficient and time consuming which is why Basic programs run so much more slowly than programs written directly in machine code.

STRING

THOSE DOLLAR SIGNS which litter Basic programs represent strings. A string is a line of characters which the computer will treat as

Which computer d

'Should I buy a computer with a large memory, and which is the best micro for games?'

IT IS DIFFICULT to give any one feature priority over another without knowing your interests. Obviously, if you are interested in graphics you will rate a high screen resolution above an extensive version of Basic or a powerful sound generator. Like cars, some home computers undoubtedly offer better performance all round but cost proportionately more.

As a beginner it is unlikely that you will need more than 16,000 bytes of memory — 16K RAM — unless you want to store a large amount of data. Most of the best games programs fit into 16K. But figures for the amount of memory a computer offers can be deceptive. An advertised 16K of RAM rarely means that 16K is available for programs.

Every home computer has an operating system. This is the machine code program which — as the term suggests — co-ordinates and runs operations such as printing to the screen, or reading in instructions from the keyboard. Although the operating system is permanently embedded in ROM it needs variables in RAM to keep track of what is happening. Consequently it reserves space in

BEATING THE BUGS

HOW TO CHECK ERRORS

FEW PEOPLE can key in a long program without making any errors. Run the program after an hour or two's hard typing and it invariably crashes. However, you can save yourself a good deal of frustration if you interpret the error messages correctly.

Although the message indicates an error at a particular line usually the fault lies elsewhere in the program. One of the most common error reports occurs when a variable has not been assigned a value. The exact wording of the message varies from computer to computer but it will probably read something like "undefined variable".

The problem here is that you cannot use a variable without having given it a value beforehand. If, for example, a line such as

100 LET A = B

throws up an error report it means that B has not been set earlier. Look through the listing and check that you have correctly typed in every occurrence of B in the rest of the program.

Another likely message is

OUT OF DATA

which will be reported at a line with a Read statement in it. Again the error is usually to be found somewhere else in the program. It indicates that the computer has not found enough items in a data statement. Either you have left out an item or you have missed a comma between them.

Syntax errors are not difficult to spot. Sinclair owners are fortunate that the computer checks each line for syntax as it is entered: on other machines it is usually sufficient to retype the line checking for missed colons or spaces. Most Basics will accept a program line without any spaces but there are a few exceptions and, of course, spaces greatly improve the legibility of a listing.

These are just some of the most frequent problems. Other bugs are more subtle and harder to detect. But if you understand the cause of an error message it is usually possible to track down the error without poring over the entire listing line by line.

S AND THINGS

single unit, or string, unless it is told otherwise. If you input

A$ = "FIRST BYTES"

and then ask it to print A$ it will print

FIRST BYTES

Many useful things can be done with strings, but string manipulation often results in knotty problems for the novice, so here is a quick explanation of string functions and their uses.

LEN(A$) gives the length — number of characters — in a string. This is useful when you need to look at each part of a string in turn by means of a

```
FOR N = 1 TO LEN(A$):NEXT N
```

loop, or want to add something to the end of the string.

VAL(A$) converts the character representing a number into that number, that is, it converts a string into a numeric variable. This is particularly useful when INKEY$ has been used for input, as INKEY$ always produces a string. Note the VAL of anything other than a number is 0.

```
10 A$ = INKEY$:IF A$ = ""THEN 10
20 A = VAL(A$):IF A<1 THEN 10
```

This rejects anything other than a number from one to nine. ASC(A$) gives the ASCII code of the first character in the string. This can be used to select a group of adjacent characters, such as the numbers one to five.

```
20 A = ASC(A$):IF A<49 OR A>53THEN 10
```

STRING$(N,A) forms a string of length N made up entirely of character A. A may be the ASCII code for a character or the character itself in quotes. Both STRING$(10,65) and STRING$(10,"A") will form a string made up of 10 letter As.

String slicing is carried out by three functions: LEFT$(A$,N) gives the first N characters, RIGHT$(A$,N) gives the last N characters, and MID$(A$,M,N) gives the middle N characters, starting from character number M. If

A$ = "THIS IS A LONG STRING"

then LEFT$(A$,4) = "THIS", RIGHT$ (A$,4) = "RING", and MID$ (A$,11,4) = "LONG". The line

```
FOR N = 1 TO LEN(A$):B$ = MID$(A$,N,1):
NEXT N
```

will make B$ = each character of A$ in turn.

When adding strings the second string is always put after the first string.

```
A$ = "LONG":B$ = "STRING":C$ = B$ + A$
```

will make C$ = "STRINGLONG" and not "LONGSTRING". Note that when adding strings you often need to add spaces as well.

```
C$ + A$ + " " + B$
```

gives "LONG STRING".

STR$(A) is used to convert a numeric variable into a string which can then be added like any other string.

```
A = 1:D$ = STR$(A) + C$
```

gives "1 LONG STRING".

To insert into a string it must first be divided into left and right portions at the appropriate point, and the various pieces added back together in the correct order.

```
E$ = "VERY":F$ = LEFT$(D$,2) +
E$ + " " + RIGHT$(D$,11)
```

will now give "1 VERY LONG STRING". This type of string manipulation is important in text editing, and also often in sound and graphic functions which are handled as strings.

String searching is carried out by INSTR(N,A$,B$) which will search A$ for B$, starting from character N. If B$ is not found the result is 0, otherwise the position at which B$ starts is returned.

One of the most straightforward uses of INSTR is in checking for valid entries. All valid keys are included in G$, and each INKEY$ value is compared with this.

```
10 G$ = "ABCDEFG"
20 H$ = INKEY$:IF INSTR(1,G$,H$) = 1 THEN 10
```

I could do that....

Travel agents' windows often feature a moving advertising display. First Byters can win £15 by sending us a program moving up to 10 characters across and down the screen, starting at the top, passing left to right, feeding into the line below, then scrolling backwards and up to the top. We are looking for simplicity and elegance.

o I need?

RAM and uses it as its own storage area.

On the BBC the O/S takes up 3.5K RAM and even the unexpanded ZX-81 has to surrender a hundred bytes to the O/S.

The screen memory also consumes RAM. Most computers map the display on to a section of RAM. Generally there is a trade-off between RAM and resolution: the greater the graphics resolution and the more colours on screen, the less memory available.

A 16K RAMpack for the ZX-81 does indeed offer a full 16K user RAM but the ZX-81 does not provide high-resolution graphics.

The best computers for games at the moment are probably the Atari and the BBC Model B. Features like graphics and sound make some computers more suitable for games programs than others. But just as important a factor is how long the machine has been around and how much software has been developed for it.

Neither the Spectrum nor the Vic can match the BBC or the Atari in their hardware specifications, yet the games for these machines are almost as good and far more varied.

It takes programmers time to discover how to make the best use of a computer — the quality of software for the ZX-81 is still improving.

The Dragon 32 arrived shortly after the Spectrum but there is a flood of programs being produced for the Spectrum and only a trickle, as yet, for the Dragon. One of the reasons for this is that it was easy for the software houses which had been concentrating on the ZX-81 to move on to the Spectrum, since it uses the same processor — Z-80 — and was assured of a large market.

Most home computers are suitable for playing games on, but buyers of new machines should expect to wait some months before the appropriate software appears.

ASCII CODES

EVERY CHARACTER on the keyboard is represented by a code and when the computer stores a character, it stores the code in a single byte. Almost all computers adopt the same set of codes — the ASCII set — pronounced askey, as in Arthur Askey. A notable exception is the ZX-81, which uses its own set of Sinclair codes.

Since one byte can hold a number from 0 to 255 the set can contain up to 256 codes but only those for the keyboard characters are standard. The other codes are usually specific to each computer and could be used for user-defined characters or predefined graphic characters or as control codes.

If you type in and run the program you can see which codes stand for which characters, on your computer. The Basic keyword CHR$ generates a character from its numerical code.

```
10 FOR N = 32 TO 255
20 PRINT N, CHR$(N)
30 NEXT N
```

You will notice that the For-Next loop starts at 32. This is because codes 0 to 31 are usually reserved for control characters. When the computer encounters one of these instead of printing a character it carries out an instruction. Control codes can be used to tell the computer to do such things as move the cursor up, clear the screen or change the colour.

Using CHR$ with control codes can be very useful for printing a number of characters to the screen quickly — enabling you to speed up games written in Basic considerably. For example, if 8 is the code for cursor left and 9 the code for cursor down,

```
PRINT "EE";CHR$(9);CHR$(8);"E"
```

would print one "E" on top of the other. But it is more useful to insert control codes in a string first, as in:

```
A$ = "E" + CHR$(9) + CHR$(8) + "E"
```

followed by PRINT A$.

This is a rather simple example. To discover what further uses control codes can be put to look them up in the ASCII table in your manual and try experimenting with PRINT and CHR$. ■

THE S ORIO

Even ice-cool Clive Sinclair is feeling the nail-biting tension. Kathleen Peel asks whether the proven virtues of the Spectrum and massive availability of software will be enough to stave off the challenge of the Oric which appears to offer more for £25 less.

EARLY ORICS were plagued with a shaky display. Now the problem has been solved with an Astec modulator but the Oric's picture is still not as good as the Spectrum's.

Both machines exhibit dot-crawl. The Oric has two modes of operation. Text, which allows the user more of the 16K for Basic programs — 12,288 bytes — and Hires — 5,120 bytes. Actual bytes free for Basic programs are calculated by reference to the Oric memory map.

The Spectrum only has 8,846 bytes free but can mix text with Hires without resorting to calling ASCII codes. The Oric picture always retains a black border and this can be a disadvantage.

Ink and Paper

If you wish to provide the effect of a green playing surface, the Spectrum permits a green or any other colour border. Both systems use Ink and Paper commands, although the global effect on Spectrum is only achieved after a CLS command. The colour resolution of the Oric, in Hires, is greater than the Spectrum.

The Oric uses a six-by-eight character cell size which produces noticeably lower character definition on a television display; the Spectrum has a eight-by-eight character cell.

The Spectrum Beep command has always

been limited in use within a Basic program, being a single channel. The Oric uses the AY-3-8912 sound chip which provides three channels capable of producing a multitude of

different sounds, plus white noise. The oddity of it all is that the Spectrum is rather quiet and the Oric's built-in commands of Zap, Ping, Shoot and Explode are rather noisy.

Both keyboards have a calculator feel. The Spectrum keys are reasonably large and the "feel" can be improved by typing Poke 23609,50. This provides audio indication of a key being pressed. The Oric keys are much smaller and spaced slightly closer together, but at least the Oric has a full-size spacebar. The keyboard plays a more important part in using the Oric as almost all words must be typed in full and therefore, require the user to be accurate in typing commands.

Oric Basic enables the user to use integers

SPEED

Spectrum on left. Oric on right.

Test 1. Array loading.

```
1 DIM b(1000)
2 FOR a=1 TO 1000
3 LET b(1001-a)=a
4 NEXT a
5 GO SUB 20: PRINT
6 LET s=0
7 FOR a=1 TO 99
8 IF b(a)>b(a+1) THEN GO SUB
30
10 NEXT a
11 IF s>0 THEN GO TO 7
12 GO SUB 20
13 STOP
20 FOR a=1 TO 100
21 PRINT b(a);
22 NEXT a
23 RETURN
30 LET d=b(a)
31 LET b(a)=b(a+1)
32 LET b(a+1)=d
33 LET s=1
34 RETURN
```

```
2 DIM B(200)
3 FOR A=1TO200
4 B(200-A)=A
5 NEXT
6 GOSUB20:PRINT
7 C=0
8 FOR A=1TO99
9 IF B(A)>B(A+1)THEN GOSUB30
10 NEXT
11 IFC<0THEN GOTO7
12 GOSUB20
13 STOP
20 FOR A=1TO100
21 PRINTB(A);
22 NEXT
23 RETURN
30 D=B(A)
31 B(A)=B(A+1)
32 B(A+1)=D
33 C=1
34 RETURN
```

Oric
Time to load array : 15s.
Time to sort array : 300s.
Space occupied by program : 225 bytes
space occupied by variables: 5,036 bytes

Spectrum
Time to load array : 13s.
Time to sort array 285.6s.
Space occupied by program : 339 bytes
Space occupied by variables : 5,037 bytes

Test 2. Drawing circles.

```
20 FOR a=90 TO 0 STEP -2
3 CIRCLE 120,92,a
4 NEXT a
```

```
1 HIRES:CURSET120,100,1
2 FORA=80TO25STEP-2
3 CIRCLEA,1
4 NEXT
```

Spectrum : 31.2s. **Oric** : 11.3s.
Unfortunately the Oric "circles" are 6.14 wide by 4.87 high.

Test 3. Drawing boxes.

```
20 FOR a=230 TO 80 STEP -4
4 DRAW a,0,1: DRAW 0,(a-80): DR
AW -a,0: DRAW 0,(80-a)
5 NEXT a
```

```
1 HIRES
2 CURSET2,2,1
3 FORA=230TO84STEP-4
4 DRAWA,0,1:DRAW0,(A-80),1:DRAW-A,0,1:D
RAW0,(82-A),1
5 NEXTA
```

Spectrum : 4.51s. **Oric** : 6.1s.

SHOOT-OUT: ORIC V. SPECTRUM

and does mean that the Oric memory requirements are smaller and that more can be packaged into a Basic program. I suggest you look at the program listings carefully; if you are new to home computing, the fact that the Spectrum spaces the text for easy interpretation with an excellent line syntax checker may be crucial. If, however, you have already mastered the fundamentals of programming, then you may prefer the additional potential of the Oric.

Relatively bug-free

It is worth bearing in mind that Spectrum Basic was developed on the ZX-80 and is now relatively bug-free. Even the IBM Personal Computer had some errors. The Oric may suffer in so far as it is a substantial step away from Microtan Basic, Tangerine's old Basic.

The Oric limits the length of a line of Basic code to 77 characters. At 75 characters, the first of three warning Pings is emitted, on the 78th character the line is deleted. There is no line-length limit on the Spectrum.

Oric's editor is worse than the Spectrum's. Edit X brings line X to the bottom of the screen. Typing Control A over characters in the line writes the characters into a duplicate line which on pressing return replaces the original line. Cursor keys delete characters, while typing a character then backspace cursor inserts characters. Unfortunately the amended line is not visible while changes are being made.

Saving and loading

Saving and loading is not without problems. The Spectrum has a printer which is a low-quality, low-cost machine and will produce screen dumps and listings very quickly.

The Oric uses a Centronics interface which operates with Strobe and Acknowledge only. This should allow you to use a wide range of printers but it has not provided satisfactory results with the printer I used.

The Sinclair manuals have been gradually refined and are now very good. The latest Oric manual is a vast improvement on the provisional offerings sent out in December and January but is still not as comprehensive as the Spectrum manual.

Last summer some micro enthusiasts had to wait 20 weeks before the Spectrums they had ordered were delivered. It is early days yet but if demand is high as Oric has stated, I wonder what delivery time scales will be achieved.

CONCLUSIONS

- When comparing machines, it is always assumed that any innovative or exceptional function of one machine shows up as an inadequacy in the other. This is not the case, both of these machines are or will be excellent value for money. If you have £125 to spend, then the Spectrum is perhaps ideal for the beginner or someone who has outgrown his ZX-81 or ZX-80 and wants a machine now. The Oric is likely to be of more use to somebody who already knows a little about computing and who will be able to break the syntax barrier.
- There appear to be many problems still remaining with the Oric's ROM, and perhaps the interface control. It is too early to talk about an extended version of Oric Basic when this particular ROM has not yet been fully debugged. It is a great pity as the potential of the Oric is far greater than that of the Spectrum, and this will obviously appeal to the more technically adventurous micro enthusiast.
- Missing commands include ACS — Arcosine — and ASN — Arcsine. They can be evaluated using Cos Sin and Arctan. Other useful commands not implemented include Copy, Verify, Merge, Flash and Double: these can be simulated using control characters. There are no disc file-handling commands which may mean a new ROM required à la BBC.
- It is important the Oric replaces the EPROMs in the early machines delivered as soon as possible and free of charge. ■

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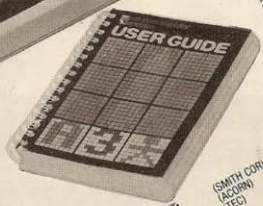

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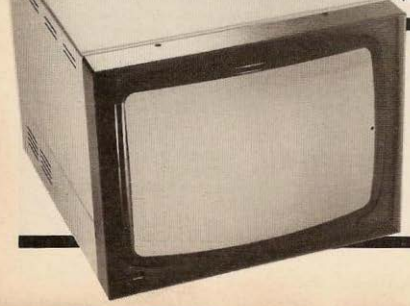

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CGP-115 LISTS IN

TANDY'S NEW four-pen Colour Graphic Printer could have the same dramatic effect on printing as the change from black and white to colour screen displays has had on computing. It is a direct descendent of the CE-150 2.25in. colour printer produced by Sharp for the PC-1500.

The printer, complete with RS-232 and Centronics interfaces, costs £149 including VAT but not including any connecting cables. It comes with a power supply, operation manual, three black pens, one each of blue, green and red, and a roll of plain paper 4.5in. wide and 180ft. long. The machine is a healthy 8.5in. square by 3in. high and weighs 1.75lb. It is coloured silver-grey, with a black top cover which is raised to gain access to the pens and their holders.

The printer can print either 80 or 40 characters per line. The ASCII character set from code 32 to code 127 is implemented, although unfortunately there is no pound sign. A switch marked special characters provides for Japanese script.

The characters are not produced by a dot matrix or burnt into aluminised paper. In either case, present technology would not permit 80 characters within a space of a little over 3.75in. The characters are formed in the machine's internal ROM and written on to the paper using ink pens. The effect is similar to high-quality type-written text. Except for the lack of proportional spacing of characters, and paper width, the performance is as good as many professional printers.

The printer has two modes of operation, text and graphics. The Graphics mode permits character size to be varied from 80 characters per line to one character per line, in 63 steps retained on return to text mode. Characters can also be rotated in 90° steps. Also available is the facility to draw 15 different types of dashed line. Colour can be changed and a return to text initiated with very simple commands.

Axes are specified in terms of X or Y with a defined step and interval. The step is a multiple of 0.008in. between 1 and 999, positive and negative, and the interval, the number of repetitions of the step, is between 1 and 255.

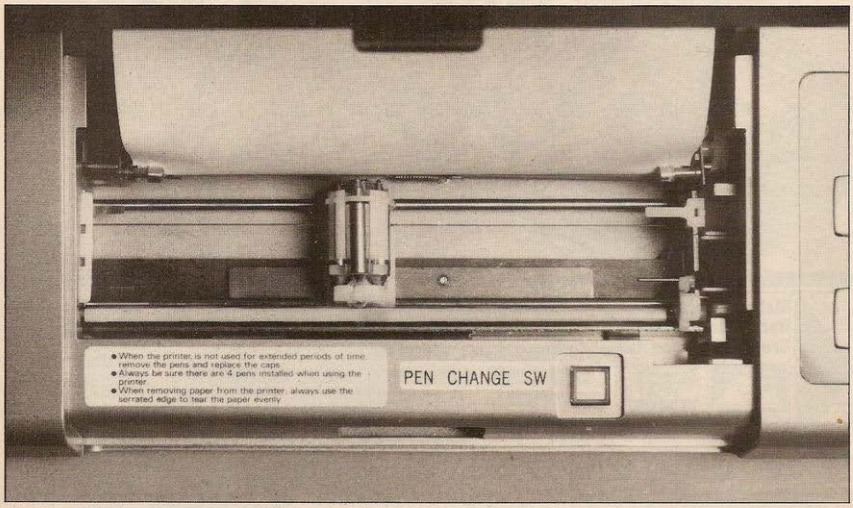
The effective X-axis resolution of 480 steps and equivalent vertical resolution draws convincing circles, without annoying steps on the edge.

The printing speed is a slow 12 characters per second. At present screen dumps of graphics are not possible.

The machine is opened by undoing five screws in the base and releasing four locking tabs to release the top moulding. The base holds the print and feed mechanism at the front. The paper drive is friction-fed by a full-length rubber compound roller and side pressure rollers which also prick the edge of the paper at 0.156in. steps. This gives the effect of tractor drive and has the advantage of providing the Y axis with a quoted accuracy of one percent coupled, with a repetition accuracy of 0.008in.

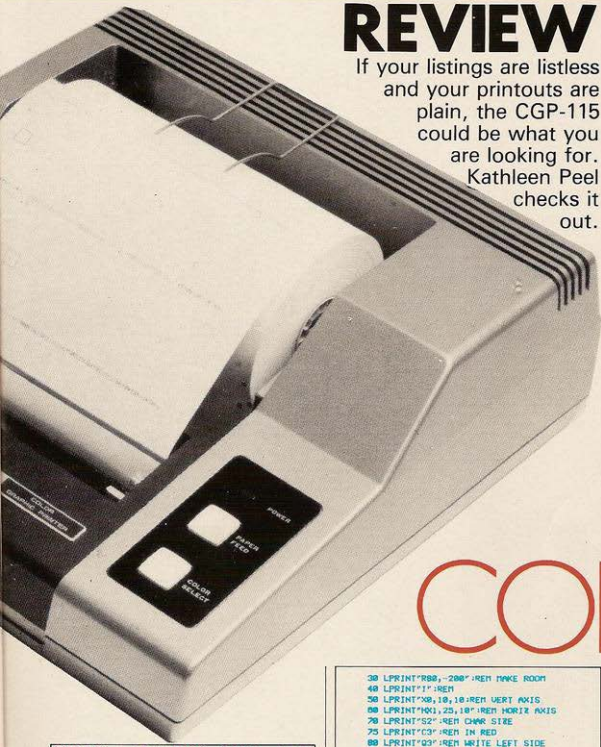
The PCB is screened from interference and the major integrated circuit components are encased in a screened box shaped around the parallel input/output socket — very professional. There is a large heat sink down the right-hand side at the rear.

The top moulding of the unit houses the power switch, serial input/output socket, and power socket at the rear. A small PCB houses the power indicator lamp, the paper-feed and colour-select push buttons. Finally, housed under the mechanism cover is the manual pen-change switch. The top cover lifts to expose instruction labels, one concerning pen



REVIEW

If your listings are listless and your printouts are plain, the CGP-115 could be what you are looking for. Kathleen Peel checks it out.



replacement and the other noting how to look after your printer.

The 50-page manual is well laid out and clear, but there are some omissions. The appendices provide some Basic programs which produce pie charts, sine and cosine curves.

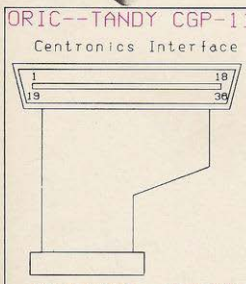
It is surprising that there is no indication of the connections on the four-way DIN socket masquerading as an RS-232 interface. Only pins 2, 3 and 4 are wired. Table 1 gives the connections. The serial interface operates at 600 baud with no parity and two stop bits.

The parallel interface is via a Centronics-type plug but the only connections used are busy — Pin 11, strobe — Pin 1 acknowledge — Pin 10 and the data lines.

Loading the paper was initially a bit of a problem. A protrusion in the centre prevented the paper from being entered into its loading slot completely, and so take up, by pressing the paper-feed button, could not take place. The answer was to cut a strip of paper 6in. long by 1in. wide and load this into the slot close to one edge, such that it could be fed through by hand. The strip was then slid across into a central position and the full paper width loaded over the top of the strip. As soon as take up was established the strip was removed. I only used this procedure twice as, whatever the obstruction was, it disappeared. Loading the pens was straightforward if a little fiddly. Neither operation is likely to be required very often.

(continued on page 48)

COLOUR



Above: sample Oric/CGP-115 printout.

```
30 LPRINT"R80,-200":REM MAKE ROOM
40 LPRINT"I":REM
50 LPRINT"X0,10,10:REM VERT AXIS
60 LPRINT"X0,25,10":REM HORIZ AXIS
70 LPRINT"S2":REM CHAR SIZE
75 LPRINT"C3":REM IN RED
80 LPRINT"Q3":REM WRITE LEFT SIDE
90 LPRINT"M-10,10:REM POS PEN
92 LPRINT"PSALE":REM WRITE VERT
94 LPRINT"M10,-40":REM POS PEN
96 LPRINT"Q0":REM WRITE RIGHT WAY
97 LPRINT"C2":REM IN GREEN
98 LPRINT"P   1983":REM TITLE
150 LPRINT"C1"
170 LPRINT"M0,0"
190 LPRINT"D20,25"
200 LPRINT"D50,50"
210 LPRINT"D100,100"
250 LPRINT"C0"
253 LPRINT"S0"
260 LPRINT:A,C4
261 FORX=1TO6:LPRINTL$:NEXTX
262 LLIST
264 END
```

Above: typical 80-character printout.

Pin	Function
1	Not connected
2	Busy
3	Earth
4	Data

Table 1. Four-pin socket terminations.

	Printout	
	Length/£	Sq. ft./£
Sinclair	27.2	9.1
Amber	129.4	24.3
CGP-115	112.8	42.3

Table 3. Paper usage running costs.

```
10 REM LINE SAMPLE PROGRAM
20 PRINT,CHR$(18)
30PRINT,"L3"
40PRINT,"J480,0"
50PRINT,"A"
60 END
```

Sample BBC/CGP-115 printout.

```
!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFG
HIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmno
pqrstuvwxyz{|}~
```

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YC3

(continued from page 45)

When the printer is switched on, the pen carrier traverses to the left-hand edge and rotates the pens to ensure that holder number one is in the top working position. The printer then draws four boxes produced sequentially by the pens in holders 1, 2, 3 and 4. This is to ensure that the user is aware of any dried-up pens.

Pressing the paper-feed button at switch on sets in motion a self-test procedure that also prints the character set in the four loaded pen colours.

CONCLUSIONS

- Tandy's new printer will transform data presentation and allow the computer to interpret results fully, for ease of reading, varying colour, indentation, and print size as necessary.
- The graphics capability provides for considerably better resolution that available to the majority of micros. The lack of a screen-dump facility is likely to be temporary as users will soon develop software to produce screen dumps in colour.
- This high-quality printer can only be faulted on paper width, and slow speed which may make it unsuitable for word processing.

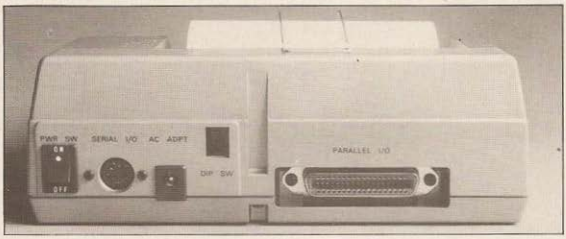

Table 2. Comparison of machines.

		Characters		Paper					Accessories		
	Colours	line	sec	Type	Width in.	Length ft.	Printer Size in.	Basic Cost £	Paper	Rib-bons	life
Sinclair Printer	1	32	50	Metal-ised	4	65	5.5 × 2.9 × 1.9	59.95	11.95 for 5		
Amber 2400	1	24	17	Plain	2.25	88	6.3 × 6.3 × 3.1	89.70	3.40 for 5	2.00 Ribbon	3 × 88ft. rolls
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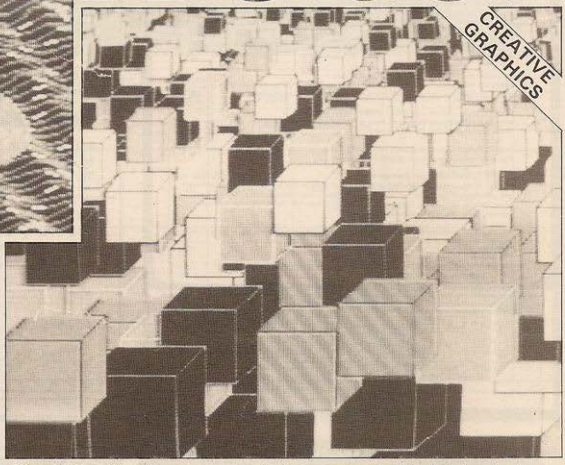
BBC SOFT



SOFTWARE FOR the BBC Micro is still pouring down like invading aliens in a video game. Most of it is improving rapidly in presentation, if not originality. Nearly all the games reviewed here have good graphics and sound, and nearly all are the close relatives of a standard arcade game. Like racehorses, arcade games produce many offspring; "by Defender out of Invaders". Unfortunately not all of these games are thoroughbreds.

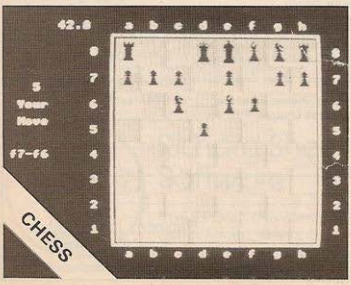
Superior Software has produced several games, all based on old favourites. The most interesting on offer is Centipede, apparently the only available version of this popular game. You have to try and destroy a fast-moving and very unfriendly centipede which snakes down from the top of the screen. There are other hostile creepy-crawlies, including a spider which menacingly bounces up and down above or on you. Visually this game compares well with the arcade version, being colourful and clear. Unfortunately, it is not possible to fire as rapidly and this can lead to many an untimely death.

Invaders and Galaxians are also produced by Superior Software. These two games, as their names suggest, are standard issue. Both, though, are well-produced, with colourful graphics, responsive controls and the usual bunch of extra-terrestrials.

Space Fighter, from the same company, is advertised as a mixture of Defender and Scramble. However, it is not as exciting or as complex as either of these games. There is a curious effect to the display; you seem to be underwater spearing fish rather than blasting baryons and mutants in the lonely sky.

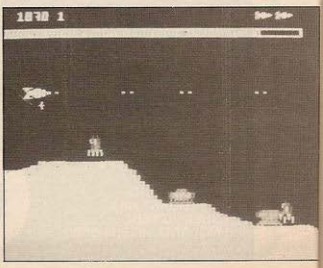
Alien Dropout, again, from Superior Software, has nothing to do with spaced-out hippies. Instead, in another variation of the Invaders and Galaxians theme, you are attacked by killer moths. Do not be fooled by their placid purple appearance — these moths are out to get more than the clothes in your wardrobe.

Alien Dropout is not as fast or as furious as Invaders or Galaxians, but it does have a certain homely charm.



The last program under review from Superior Software is Fruit Machine. This gives you a fruit machine on your screen. You can nudge or hold, collect or gamble. It is just like the real thing — except, of course, that there is no money. The program generously gives you a credit of 20 to begin, and when it has cleaned you out you can start all over again. It is difficult to image who this program will appeal to; are there fruit machine addicts who play for the sheer fun of it? If so, then this is their program. The graphics are very good and with a little imagination you might be able to convince yourself you are in Las Vegas. Perhaps it will help to wean compulsive gamblers.

From Program Power come Alien Destroyer and Laser. Both have good, colourful graphics and a range of skill levels. The first is an Invader-style game with a variety of bombs and attackers. An engaging detail is the little yellow man who leads you back to the starting position when you have been destroyed. Another bonus for connoisseurs is the Battle Report you receive after each game; percentage of hits, number of torpedoes fired, and so on. Laser is a version of Missile Command, and quite a good one. All the familiar features are there and the player has a



SURVEY WARE

wide range of options — perhaps too many *unless you are as familiar with the keyboard as a touch-typist.*

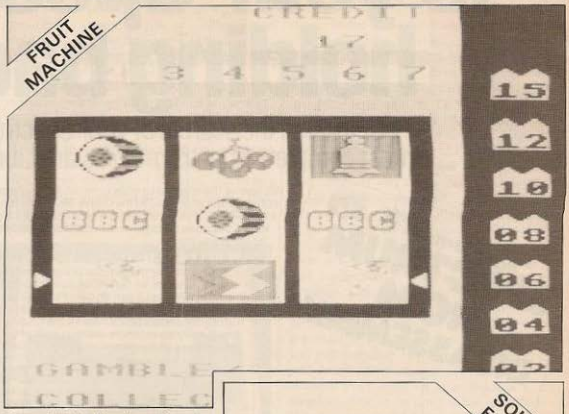
The new version of Chess by Program Power is a great improvement, mainly because it is now in colour. The board is very clear — in bright red and green — and the pieces are well-defined. It plays a vigorous attacking game at level 2 and makes its moves very quickly. It is prone to commit a computer's version of human error — that is, losing its queen — but obviously plays a more thoughtful game at the higher levels.

In contrast to games of death and destruction, BBC Software have produced a tape called Games of Strategy. If there's anything left of your brain after a few hours of Galaxians you might like to try Galaxy, Gomoku, Masterbrain or Reversi.

In Masterbrain you have to discover a four-figure digit the computer is "thinking" of, and it has to discover yours. Reversi and Gomoku are both well-known territorial possession board games. Galaxy is another territorial game, pitting you — on board the starship *Endeavour* — against the invading Kryons. By plotting co-ordinates on the screen you can destroy the invaders by firing phasers and photon torpedoes. None of these games is particularly interesting graphically, but that's not the point. If you like board games or logical games, you might enjoy them.

Acornsoft's version of Galaxians is called Arcadians and is written by someone calling himself Orlando. Perhaps he really is called Orlando. Pseudonymously or not, Orlando has written a very good program; definitely the best available Galaxians-style game for the BBC. A jolly little tune announces the beginning, after which you are rapidly destroyed. But you soon get the hang of it, and the game improves as you proceed through the pages.

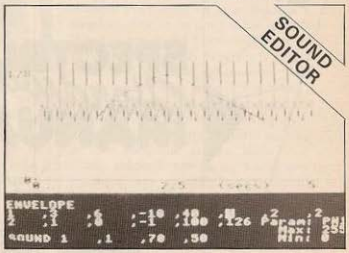
Although not written by Orlando, Acornsoft's Super Invaders is also the best of its kind for the BBC. It has three levels of difficulty. The first two, A Mild Encounter and An



Uncomfortable Situation, are in the traditional mould with the invaders and their missiles encroaching more quickly on your position. In the third level, rather exaggeratedly called A Terrifying Experience, the invaders' bombs float down and home in on you. They do not often miss. This is an exciting and well-executed version of a game which had almost lost its interest.

Better than both these games, though, is Rocket Raid, Acornsoft's answer to Scramble. You must pilot your ship over jagged landscape, bombing the fuel dumps and blasting the rockets. The controls are similar to the ones used in Defender but are more conveniently positioned on the keyboard. This first stage is deceptively simple.

No sooner have you successfully negotiated these paltry obstacles than you are confronted by one of the most awesome sights in home computer games; the cavern. Grown men have screamed in anguish as, time after time, their ships has been destroyed by the viciously oscillating green yo-yos called phizzers. Eventually of course, you get through, only to be confronted by the meteorites — approaching at different altitudes, they cannot be destroyed but must be avoided. With your



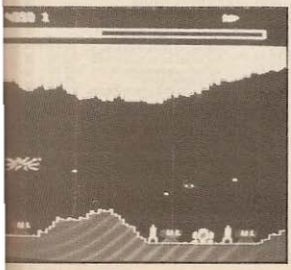
nerves shot to pieces by the ordeal of the Cavern you do not last long here. So you go back, to the beginning, to the Cavern and the phizzers and . . . When you have flown about a hundred missions you might get through to the skyscrapers, or the maze, or even the fabled deserted city. Then you can start all over again.

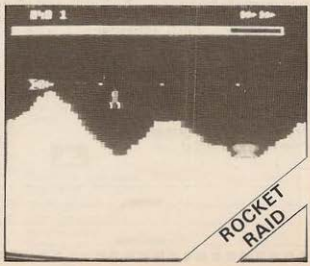
All three games have excellent graphics and sound quality and are probably worth the extra money as they are definitely the best on the market.

Level 9 have produced two adventure games; Adventure Quest and Dungeon Adventure. These two programs seem to be an attempt to exploit the vogue for fantasy and role-playing games such as Dungeons and Dragons. Add a touch of Tolkien and just a hint of *Conan The Barbarian* and you have the scenario; quaintly-yclept wizards and knights encounter evil and violence — but no sex — in steaming primeval forests and war-ravaged wastelands.

Beneath the odd vocabulary and exotic props they are, of course, ordinary adventure games. As such, they are as good as any other. You are an apprentice wizard who, in order to save Middle Earth has to seek out and destroy the evil Lord Agaliarept in his dark tower. When I was an apprentice wizard I was quickly eaten by ravenous wolves but the program kindly resurrected me and I received the blessing of Typo, God of Adventures. It

(continued on page 53)





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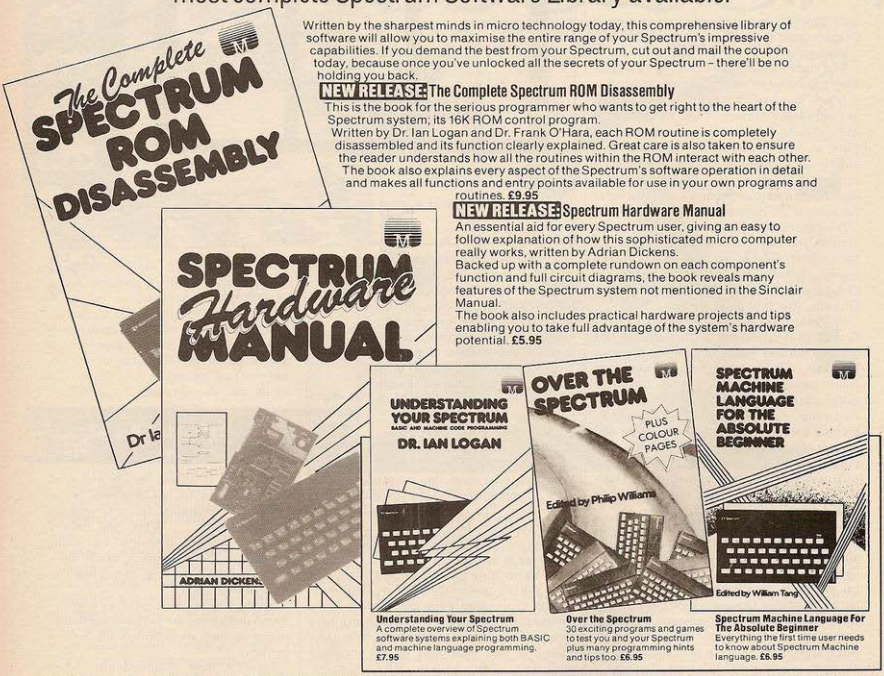

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(continued from page 51)
did not do me much good, and for all I know the Middle Earth is still waiting to be saved by a brave and ingenious adventure game fan.

Dungeon Adventure is related to the previous game; now you must find the dead demon lord's treasure in his black tower. Both these programs have a Save facility and come with an explanatory booklet. Enclosed is a stamped addressed envelope which entitles you to one clue from Level 9.

It was encouraging to see that software houses are now producing more programs of a practical or educational intent. Program Power offer Constellation, which enables the user to view the stars from any point on the Earth's surface, on any date and at any time. You enter latitude and longitude, date and time and telescope elevation; and, behold, on the screen is displayed a map of the heavens!

You can zoom in or out, thus allowing you to have a close-up of one particular constellation or a broad view of the whole area. This program will probably appeal mainly to budding astronomers as an easy method of finding their way about the stars before going on to the real thing.

If you are more interested in money than the mysteries of the cosmos, then Compute-a-draw from Davansoft will be more to your taste. Its manufacturers claim that by using it carefully you can predict draws with about 20-30 percent more success than picking them with a pin. They do not promise you a fortune; only the opportunity of winning several smaller dividends each season.

This program comes in two parts; the prediction program, £4.95, and the database, £13.50. The latter is, obviously, essential and the work that has gone into it justifies the price. It contains the results from about 6,650 matches over the last three seasons, up to January 15 of this year. If you do buy this program, then you will have to be prepared for a fair amount of work; adding information to the database, running the program before making selections, reading the copious explanatory notes.

Perhaps the most difficult commands to master in the BBC Micro's repertoire are the Sound and Envelope commands with their 18 parameters. Davansoft's Sound Editor is designed to make them easier to use. It draws the graphs of the pitch and amplitude envelopes over the same axes; the parameters are printed below and can be easily entered by moving the cursor. When you alter one of them the program enables you to discover the effect by redrawing the envelope shape and producing the new sound.

BBC Software has produced two programs exploiting the graphic capabilities of the BBC computer; Painting and Drawing, both by Brian Smith of the Royal College of Art. Although the controls for these two programs are rather complex, they both come with clear explanatory booklets. In Painting you have a good variety of colours to choose from. There is also a choice between brush and airbrush — which "paints" in a cluster of dots. Other

options are to vary the width of brush, use hatching or vary background colours. Drawing allows you to create circles, polygons and other shapes with different sizes and effects. In both of these programs brush or line movement is controlled by the cursor keys; it is thus rather difficult to draw, for instance, a curve. If you want to explore the BBC's graphics these programs could be useful. If you want to learn how to draw then you should buy pencil and paper.

Anyone who is interested in making the most of the BBC Micro's graphics might be better advised to take a look at Acornsoft's Creative Graphics. Best described as a compendium of graphics techniques and ideas, the tape contains 36 Basic programs which produce a variety of pictures and patterns. These include rotating 3D shapes, animated pictures and elaborate and constantly-changing designs.

One of the most impressive things about this collection is how short the programs are. Few of them would take long to key in; yet they achieve the sort of effects that are only available with machine code, if at all, on most other home micros. This reflects both on the scope of the BBC Basic and the ingenuity of the author, John Cownie.

To extract maximum benefit from these programs the aspiring computer artist should buy the Creative Graphics book, which is available separately for £7.50.

Acornsoft's Tree of Knowledge is an educational game in two parts. The first, Fruit, is intended for children of primary school age. Either they ask the computer, or the computer asks them, questions whose aim is to discover the fruit thought of. The computer might ask "is it a citrus fruit?" and if the children do not know what this is they will find out, thus placing citrus fruits on the Tree of Knowledge. This idea of classification and connection is continued in the second program, Class, which is meant to increase a knowledge and understanding of the classification of living creatures. You think of an organism and the computer asks "is it green and multicellular?" From your answer to this and succeeding questions the computer consigns your organism to a kingdom, a sub-kingdom, and so on until it has identified it. When it has found your creature it gives a smug "Ho-ho". This program is specifically aimed at A-level biology students — a point driven home to me when I was asked if my organism was diploblastic, coelomate and had a notocord. For them it will be very useful as a means of learning why creatures are classified in their particular groups. Both Fruit and Class, although having no sound and few graphics, are enjoyable and worthwhile educational games.

Wordwise, a word processor on a ROM chip from Computer Concepts, is considerably more sophisticated than most of the word processors available on tape.

The advantage of having software in ROM is that it can occupy the memory space that would otherwise be filled by the Basic interpreter and so does not take up any user RAM. This means that there is room for 24,560 characters to be stored — about 4,500 words. Wordwise, incidentally, keeps a count of the number of words typed in, which it displays in a status line at the top of the screen.

Another bonus is that a program in ROM is instantly accessible. To switch from Basic to Wordwise you simply type in *Wordwise, and *Basic to switch back.

On some word processors the screen can be horizontally scrolled over a much wider page of text. With Wordwise text must be entered and edited in Teletext mode. It can then be viewed in a formatted state at 80 characters to the line.

There is an extensive range of editing facilities most of which are easy to use. Sections of text can be readily deleted, shifted and copied; previously-Saved text can also be inserted from tape or disc. A search option allows you to replace every occurrence of specified string of characters by an alternative string.

These are just some of the features Wordwise offers. At the moment it is probably the most useful word processor on the market and is the only one on a chip. It will be interesting to see how Acornsoft's View — which will also be in ROM — compares. ■

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BBC Software, BBC Publications, PO Box 234, London SE1 3TH.	Games of Strategy	£10
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	Fruit Machine	£6.50
Computer Concepts, Dept YC4 16 Wayside, Chipperfield, Hertfordshire WD4 9JJ.	Wordwise	£45

MOZART LIVES

YOU CAN COMPOSE instant Mozart with a little known opus called the *Dice Waltz*. In effect, this was an automatic generator of minuets. This claim holds true in spite of the fact that Wolfgang Amadeus never heard most of the theoretically possible 4.6E16 variations! It was constructed in this manner: Mozart assembled 176 musical bars of two types, suitable for the two parts into which each "minuet" would be divided. The two groups of 88 bars were arranged into tables of eight columns and 11 rows, each element of a column representing a single, three-eight bar.

In each column the bars were written or selected such that any bar in one column could be played after any bar taken from the column to its left, and before any bar taken from the column to its right. In the first table, a sequence of bars selected in order from the first to the eighth columns would combine to form a minuet beginning in the key of the tonic, and modulating by the last bar to the dominant — for example C to G. Providing the normal symmetry, though not that of the traditional AABA minuet, the second table contributes bars opening on the dominant and working their way back to the tonic. Each half would of course be repeated, giving a total of 32 bars per minuet.

As the title of Mozart's work suggests, the bars to be played were chosen by throwing a pair of dice. The range of numbers possible from a pair of dice is two to 12, and so the rows of the two tables were labelled accordingly, 16 throws in all generating the required bars in a hopefully random fashion. Loaded dice would definitely have been a disadvantage in this context.

In practice, Mozart compiled three tables. The first two were organised in the manner just described, each cell containing a number from one to 176, pointing to one of the bars written out on full double staves in the third table. One cannot help feeling that he conceived the whole thing with computers in mind; the manuscript table of the bars was a serial table, and so presumably, if a sequence was to be played through on the piano or clavichord with any comfort, the bars would have to be transcribed in full on to a separate sheet of manuscript.

Our program attempts to preserve the flavour of the original. The user actually throws the dice, which tumble across the screen to reveal the desired numbers on their two faces. And to complete the charade, appropriate numbers appear on the other two visible faces. A count of the number of throws made is displayed, and on completing 16 throws, a tabular record of the dice numbers is provided. Next, the manuscript of the music generated by the dice sequence may be printed on the screen in two sections, representing parts one and two of the minuet. After each part is printed, like the original, in three voices and on two staves, the option is given to Save the manuscript. This will be as hard copy if a printer is connected, or on tape as a named Screen if not. Then, after prompts for volume and tempo, and in one of two keys, the music will be played through in three-part harmony, and of course, may be repeated if desired. Other refinements are included, such as the ability to fix the dice, and so generate a predetermined sequence of bars.

By now the astute reader will have realised the *raison d'être* of the hardware. Valiant though it is, the Spectrum beeper cannot cope with more than one voice at a time. A General Instruments chip, the AY-3-8910 provides not only the three sound channels needed for our purpose, but also two entirely independent and bi-directional I/O ports, each of eight bits. Moreover, the chip is simplicity itself to program for most purposes, either in machine code or Basic, and equally convenient to drive in hardware terms. The spare appearance of the PSGIO board — Programmable Sound Generator and Input/Output — will bear the latter out.

Having said that the Spectrum beeper is not man enough to handle full-blooded, three-part Mozart, some readers will no doubt be relieved to hear that the software can be largely proved using the beeper before any hardware is actually connected. In fact, the program will automatically detect the lack of the interface and default to beeper. It must be stressed however, that the beeper routine gives only a very crude foretaste of the real thing.

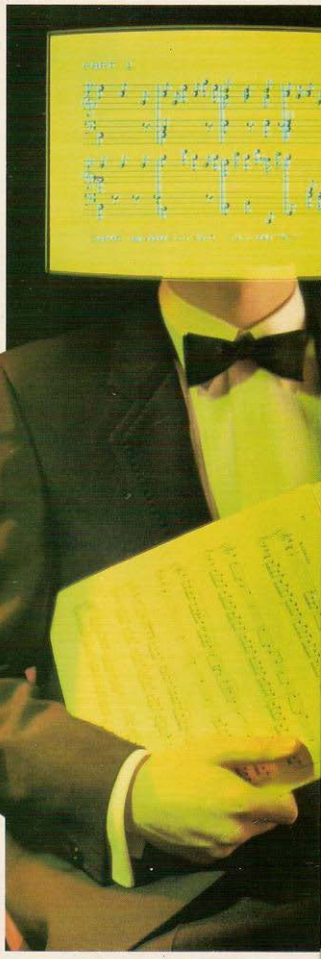
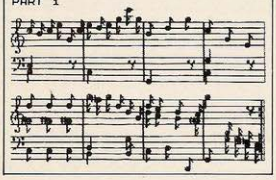


Figure 6. Sample stave.

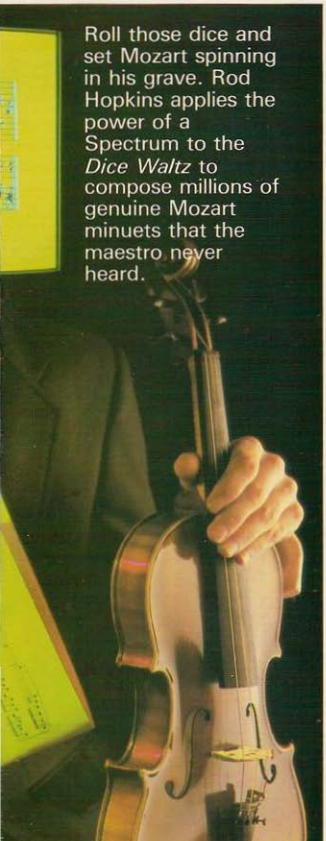


The circuit of the PSGIO board is very straightforward, using only the AY-3-8910, two cheap 14-pin LS TTL integrated circuits, a common eight-pin audio amplifier chip and a small handful of discrete components.

It lays out naturally on 0.1in. pitch Vero board, with very little in the way of track-cutting or wiring involved. A ZX-81 type connector should be used, since this allows the simultaneous use of a ZX Printer. This connector has 23 pins per side, as opposed to the 28 boasted by the Spectrum; the shell of the printer extender will only admit a 23-way

SPECTRUM

Roll those dice and set Mozart spinning in his grave. Rod Hopkins applies the power of a Spectrum to the *Dice Waltz* to compose millions of genuine Mozart minuets that the maestro never heard.



connector. Taking this course also has the advantage that the board might be used with a ZX-81.

It is recommended that the connector be mounted on the board itself, and the whole plugged directly on to the Spectrum or printer connector without intervening wiring. The Spectrum is frustratingly sensitive to the loading caused by even the shortest of cables.

All of the components used in the circuit are readily available from the majority of suppliers advertising in the electronics monthlies.

Communication with the PSG is register-orientated. In practice, this means that the programmer first tells the chip which register he wishes to alter or read, and then sends or retrieves the relevant data to or from the register specified. All functions are controlled internally by the PSG, and may persist thus while the controlling program is busy with other matters. To perform these functions, the PSG makes use of the data programmed into its register array, numbered 0-15. Table 1 summarises the signal requirements of the two control pins of the 8910 that are used.

Table 1.

BDIR	BC1	
0	0	Inactive
0	1	Read from PSG
1	0	Write to PSG
1	1	Latch PSG Register Address

They are met by decoding two I/O addresses — that is, eight-bit addresses combined with the CPU signal IORQ — to talk to the chip, namely 221 and 223. The former address plays a dual role: OUT 221,X will prepare the PSG for a data transfer involving register X. On the other hand, IN 221 will have as its result the contents of the register last pointed to by an OUT 221 instruction: for example, PRINT IN 221 will print those contents. The other I/O address used, 223, is the output data destination address, if you like. OUT 223,Y writes the value Y into the register last referred to by an OUT 221 instruction.

All of the PSG registers are eight-bit registers, although some of them are handled as pairs. Note that Bit 0 is the least significant bit — LSB — while Bit 7 is the most significant — MSB. If two registers are combined, the register with the higher address — number — constitutes the most significant byte, the summed value of their contents being the low-register value plus 256 times the high-register value.

The value of each register bit, of course, can only be either a logic 1 or a logic 0; but, in their proper positions, the bits collectively form a binary number whose decimal equivalent can be calculated by adding together the weighted values of any bits set to 1, thus:

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	
1	1	1	1	1	1	1	1	
128	64	32	16	8	4	2	1	= 255
1	0	1	1	0	0	1	1	
128	0	32	16	0	0	2	1	= 179

If, for instance, a register contained zero, all bits would be reset, that is logic zero. And, to set a particular bit to logic 1, simply write into the register the decimal value of that bit, plus those of any other bits required set. Conversely, if a register were to contain 255, that is, all bits set to 1, and the need were to reset to zero bits 0,1 and 2, it would be necessary to write into the register:

(255-4-2-1) = 248

Now to move on to the PSG registers. Remember first of all that the chip has three sound channels, referred to as A,B and C; and note further that the two highest registers, 14 and 15, are used to transmit and receive data via the two I/O ports available. The PSG registers are utilised as follows:

Register

0, 1	Set Channel A Tone Period
2, 3	Set Channel B Tone Period
4, 5	Set Channel C Tone Period
6	Set random noise period on all channels.
7	Enable noise and/or tone on all channels. Control direction of I/O transfers for both ports.
8	Set Channel A amplitude
9	Set Channel B amplitude
10	Set Channel C amplitude
11	
12, 13	Set Envelope period and shape according to same pattern.
14	I/O Port A data
15	I/O Port B data

Channel tones are set by writing values into registers 0-5, each voice using two registers.

(continued on page 57)

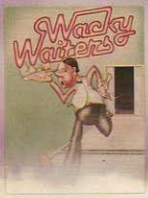
Figure 1. The Basic program.

```
"MINUETZ"

R.K. HOPKINS & M.J.LAVERTY 1983

  1 CLEAR VAL "28929": LOAD ""C
ODE : GO TO VAL "3"
  2 SAVE "A                "SCREEN$
RETURN
  3 LET B=VAL "1": LET A=B-B: L
ET C=B+B: LET D=C+B: LET E=D+B:
 LET F=E+C: LET VO=C: LET KY=(E+
B)/F: LET R=VAL "221": LET RO=R+
C: LET D=VAL "32159": LET RO=LO
+B: LET DT=VAL "31518": LET D1=V
AL "31998": LET VT=VAL "32161":
LET BV=VAL "32291": LET AN=VAL "
32293": LET SORT=VAL "32276": LE
T RNDT=VAL "32203"
  4 OUT R,A: OUT RO,F: LET PL=V
AL "23350"+137: IN R<>P: IF PEE
K 31416()148 THEN LET KY=B/KY
  36 LET O=VAL "256": LET L=RND*
O: RANDOMIZE L*O: LET KY=B/KY: G
ORDER A: PAPER A: INK E+D: CLS :
  37 LET AU=A: LET CO=A: POKE VAL "2
3658",F+F: PLOT E+F,40: DRAW A,1
20: DRAW 220,A: DRAW A,-120: DRA
W -220,A: OVER B: PRINT AT D,E;"
DO YOU WISH TO ...;AT F,E;" 1. GA
MBLE WITH THE DICE ?  or
,";AT F+E,E;" 2. PREDICT THE FAL
L OF
";AT F+E+E,E;" 3. COMPOSE AUTOMA
TICALLY?": INPUT " ENTER 1,2 OR
3 ";A$: IF A$="3" THEN LET AU=B:
 GO SUB 9930: GO TO 207
  38 OVER A: IF A$="2" THEN LET
CO=B
  40 INVERSE A: DIM M(10): FOR G
=A TO 15: PRINT AT 21,A;"THROW [
ENTER ]": PAUSE VAL "4E4":
  41 LET M=INT (RND*F)+B: RANDOM
IZE RND*SE4: LET L=INT (RND*F)+B
  42 IF CO THEN INPUT "No. ON LE
FT DICE ?";M: IF M<B OR M>F THEN
 GO TO 42
  43 IF CO THEN INPUT "No. ON RI
GHT DICE ?";L: IF L<B OR L>F THE
N GO TO 43
  44 POKE LO,M: POKE RO,L: POKE
RNDT+D,L+M-C: LET M(G+B)=L+M
  50 DATA 339,160,188,165,170,12
5,217,138
  60 CLS : RESTORE 50: FOR z=1 B
TO -17 STEP -27: FOR n=B TO C: R
EAD x,y: GO SUB 9000: NEXT n: CL
S : NEXT z
  200 PRINT AT A,A; RANDOMIZE US
R D: PLOT E,171: DRAW 22,A: DRA
W A,-14: DRAW -22,A: DRAW A,14:
PRINT AT B,B; INVERSE B;U+B; INV
ERSE A; NEXT G: INPUT "ENTER" T
O CONTINUE";A$
  205 FOR n=B TO 22: RANDOMIZE US
R 3582: POKE 23692,-B: PRINT "08
0000": NEXT n
  207 GO SUB VAL "9890": DIM M(1)
: IF AU THEN GO TO 9-F
  210 LET P1=B: INPUT "Manuscript
?(Y/N)";A$: IF A$<>"Y" THEN GO
TO 9-F
  220 POKE RN,209: GO SUB VAL "93
16": PRINT AT A,A; PART ;P1; PO
KE RN,209+(P1-B)*B: GO SUB 8500;
 INPUT " SAVE manuscript ?(Y/N)
;A$: IF A$<>"Y" THEN GO TO 230
  222 INPUT "TITLE ? ";A$: IF LEN
A$>F+E THEN LET A$=A$( TO F+E)
  224 IF IN 251=0-B THEN FOR N=B
```

(listing continued on page 57)



Imagine

..the name of the game

Imagine Software, Masons Buildings, Exchange Street East, Liverpool, Merseyside L2 3PN. Telephone: 051-236 0407

(continued from page 55)

Of each pair, the higher register only uses the four lowest bits. This means that the highest combined value that can be programmed for any channel is:

$$255 + 256 * (8+4+2+1) = 4095$$

An external oscillator or clock frequency is applied to pin 22 of the PSG chip. As a preliminary, this frequency is divided by 16 before being directed to the three channels, where it is further divided down by the numbers stored in the relevant tone period register pairs, producing the output frequency for each channel:

$$\frac{\text{CLOCK frequency}}{16 * \text{Tone Period Value}}$$

Amplitude Control is set by ignoring envelope control and writing into registers 8,9 and 10 any value from 0 to 15, the resulting volume being proportional to the number programmed.

To enable the channels and the I/O individual bits of register 7 are used for this purpose as follows:

1 = O/P 0 = Channel ON
0 = I/P 1 = Channel OFF

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
I/O	I/O	C	B	A	C	B	A
		NOISE			TONES		

Writing (255−4−2−1) = 248 into register 7 would thus switch on the tone outputs of all three channels, switch off noise on all three, and set both I/O ports to output mode. These bit switches are active when zero.

When you have built or acquired a PSGIO board, try the following routine, which simply demonstrates how to transfer a tone from channel A, and then switch it off. It is as easy as that, and the most complicated sound programs are little more than collections of similar instructions:

Program line	Rem
10 OUT 221,0	Point to channel A register 0.
20 OUT 223,200	Set tone period to 200. Leave register 1 at zero
30 OUT 221,8	Point to register 8.
40 OUT 223,10	Set channel A volume to 10.
50 OUT 221,7	Point to register 7.
60 OUT 223,254	Switch on channel A only bit 0 now equals 0.
70 INPUT "Press ENTER to switch off",A$	
80 OUT 223,255	PSG still pointing to register 7. Writing 255 to it sets bit 0 to 1.

Do not bother typing in the remarks; they are only included to make your code quite certain as to what the routine is doing. Try adding extra lines in between lines 10 to 50 to program tones or noise for channels B and C. Remember to set the volume for each voice used, and to change line 60 to switch the required voices on.

First the Basic program — see figure 1. The only points to watch are that the length of line 1 remains unaltered; music manuscript file names are Poked into the Save expression in the following line, so that any additions to line 1 could cause havoc. Also, be careful with the machine-code addresses set up at the beginning of the program. Save the Basic at

(continued on page 59)

(listing continued from page 55)

```
TO LEN A$: POKE VAL "23788"+N,CO
DE P$(N): NEXT N: GO SUB 9: IF
N=B TO F+E+1 POKE VAL "23735",N,C
ODE : NEXT N: GO TO 230
5260 LPRINT A$: LPRINT !(COPY :
LPRINT
230 LET P1=P1+B: IF P1<C THEN G
O TO 220
252 INPUT "ENTER VOLUME(1-6) ";
VO: IF VO>6 THEN GO TO 252-E
253 INPUT "TEMPO (1-6) ";L: IF
L<B OR L>F THEN GO TO 0-D
254 POKE VAL "32385",115+L+F: I
NPUT "ENTER TO VAL ";A$: LET
FOR N=VAL "31416" TO VAL "31517"
STEP C: LET L=(PEEK N+0*PEEK (N
+B))*VO: POKE N,L-INT (L/0)*0): :
POKE N+B,INT (L/0): NEXT N: GO
SUB VAL "9920": CLS : GO TO F
3530 LET Z=A: POKE BV,240: DIM N
(7): FOR V=B TO D: RANDOMIZE USR
SORT: LET TS=UT: LET YS=CODE "P
": FOR G=B TO C: FOR L=A TO E
3540 DIM A(7): FOR T=C TO F+B: L
ET N(T)=PEEK TS: LET TS=TS+B: IF
N(T)>14:T THEN LET A(T)=B: LET N
(T)=N(T)-128
3548 NEXT T: GO SUB 8660
3550 LET P=10+L*60: FOR T=C TO F
+B
3560 LET U=B: IF NOT S(T) THEN G
O TO 8630
3570 LET X=P+(T-C)*10: LET Y1=(N
(T)-B)*B: IF (V>B AND Y1>14) OR
(V<B AND Y1<B8) OR (V=B AND Y1>5
0) THEN LET U=-B
3575 IF Y1 OR Y1=F OR Y1>72
AND V<B AND INT (Y1/F)=Y1/F THEN
LET Z=B
3595 LET Y=Y5+Y1: IF S(T)<>5 THE
N GO TO 8610
8590 IF U<C THEN GO TO 8630
8600 LET Y=Y5+32: IF U=B THEN LE
T Y=Y+32
8605 CIRCLE X,Y,B: GO SUB 8775:
GO TO 8630
8620 CIRCLE X,Y,B: CIRCLE X,Y,C:
PLOT X+C*U,Y: DRAW A,11*U: GO S
UB 8775(T)
8625 IF Z THEN PLOT X-E,Y: DRAU
B,A: IF U<Z THEN PLOT X-E,Y-F: D
RAW B,A
8626 IF V AND v=B THEN PLOT X-E,
Y+F: DRAW F,A
8627 IF A(T) THEN PLOT X-B,Y: DR
AW F,A: PLOT X+C,Y: DRAW E,A:
PLOT X-7,Y-C: DRAW A,F: PLOT X-E
,Y-C: DRAW A,F
8630 LET Z=A: NEXT T: NEXT L: LE
T YS=UT: NEXT G: POKE BV,240+V: N
EXT V: RETURN
8660 DIM S(7): IF NOT N(C) THEN
GO TO 8670
8665 LET G=A: FOR N=C TO F: IF N
(N)>G THEN LET G=N(N): NEXT N: G
8666 NEXT N: IF NOT G THEN LET S
(C)=C: LET S(E)=C: LET S(F)=C: R
ETURN
8670 FOR N=C TO 7: IF NOT N(N) T
HEN LET S(N)=5: LET N(N)=B: NEXT
8710
8690 IF N(N)=N(N-B) THEN GO SUB
8730: GO TO 8710
8700 LET S(N)=B
8710 NEXT N: RETURN
8730 FOR O=B TO D: IF N(N-O-B)<>
N(N-O) THEN LET S(N-O)=S(N-O)+B:
RETURN
8732 NEXT O: LET S(N-E)=S(N-E)+B
: RETURN
8771 DRAU D,-E*U: DRAU -D,E*U: D
RAU A,-E: DRAU D,-E*U: RETURN
8772 DRAU D,-E*U: RETURN
8773 DRAU D,-E*U: CIRCLE X+E,Y,B
: RETURN
8774 RETURN
8775 DRAU S,C,P1: DRAU -D,-B: RE
TURN
9000 PLOT X,Y: DRAU S,s*D/E: DRA
U S/-s/C: DRAU -S/-s: DRAU -S,s*
D/E: DRAU A,-s: DRAU s,-s*D/E: D
RAU OVER B;A,s: DRAU A,-s: DRAU
s,s: DRAU A,s: RETURN
9800 POKE VAL "32291",240: INPUT
"Repeat ?",a$: IF A$<>"Y" THEN
RETURN
9830 POKE VAL "32291",240: FOR N
=B TO F+B: OUT R,N: OUT R0,A: NE
XT N: OUT R,E+E: OUT R0,E+V0: OU
T R,F+B: OUT R0,E+V0: OUT R,F+E:
OUT R0,E+V0: OUT R,F+B: OUT R0,
240
9835 RANDOMIZE USR PL: OUT R,F+B
: OUT R0,-B: GO TO VAL "9800"
9990 LET P=DT-11: FOR N=B TO 15:
LET P=P+11: POKE RNDT+N,PEEK (P
+PEEK (RNDT+N)): NEXT N: IF AU T
HEN RETURN
9900 CLS : PRINT AT C,F;"Dice
Record": PLOT A,145: DRAU C-D,A:
DRAU A,-70: DRAU -D+B,A: DRAU A
,70: PLOT E,60: DRAU D,-D: DRAU
B: FOR K=A TO B: PRINT AT F+K*E
,D;"PART";K+B; FOR M=B TO B: P
RINT TAB 5+N*D;M(K*3+M): NEXT M
: NEXT K: OVER A: RETURN
9915 BORDER D*E: PAPER D*E: INK
F*D: CLS : LET O=9923: LET Z=14:
GO SUB 9: LET Z=N+E: GO SUB 9:
LET L=N+C*F: GO SUB 9: LET L=N+F
: GO SUB 9: LET L=N+F: GO SUB 9:
LET L=122: GO SUB 9+B: LET M=F
*F: PLOT A,M: GO SUB 9+C: LET M
=114: PLOT C,M: GO SUB 9+C
9917 FOR N=D-B TO 4S STEP -61: P
LOT A,N: DRAU A,50: NEXT N: PLOT
DRAU A,50: NEXT N: PLOT D-E,14:
DRAU A,50: LET L=80: CIRCLE E,2
0: CIRCLE L,65,B: CIRCLE L,59,
B: CIRCLE L,65,B: RETURN
9922 FOR N=C TO L+E+F STEP F: PL
OT A,N: DRAU O-B,A: NEXT N: RETU
RN
9924 PLOT E,L: DRAU E,A,C: DRAU
-C,C: DRAU E,P: DRAU -C: DRAU -9,
-9: DRAU E+F,A,3: DRAU -
: CIRCLE E,8,B: RETURN
9926 DRAU F,A -C: DRAU F,C+F/-
1,F: CIRCLE C,M-B,B: CIRCLE 11,M
-B: CIRCLE 11,M-F,B: RETURN
```

```
9930 LET L=RND*C: RANDOMIZE L:R
ND*C: POKE RNDT+N,RND*
10: NEXT N: RETURN
```

Figure 2.

```
BARTABLE :LOCATED AT 28930-31413

B    K13  C5-  M2.  M1.  MH1  A2.
     K13  C5-  M2.  M1.  MH1  A2.
     H10  B5-  F2.  H1.  H05  F2.
     H10  A5-  F2.  J15  H52  F2.
     H15  E1.  J1.  H1-  I52  J1.
     H15  M1.  J1.  J1-  110  J1.

B    J5.  F1.  JF5  E15  J1.  F1.
     F5.  J1.  JF5  E15  J1.  F1.
     J5.  F1.  HE5  E15  E1.  F1.
     H5.  F1.  HE5  F15  C10  F1.
     J5.  F1.  JF5  E15  J1.  F1.
     H1.  1!.  11.  E1.  0!5  F1.

B    F5.  J5.  040  F52  A2.  J5.
     F5.  J5.  040  A52  A2.  J5.
     A5.  H5.  L40  F52  F2.  J5.
     A5.  J5.  L40  J52  F2.  J5.
     :!!  F2.  H4.  F!!  J5.  H2.

B    M1-  F1.  J1.  K13  110  JF.
     M1.  J1.  J1.  K13  010  JF2
     01-  M10  H10  C10  F.J5
     T1-  M10  F1.  J15  M10  JF2
     H1.  H15  H15  E1.  J1.  JF.
     H1!  L1$  A1!  H15  0!.  JF.

B    K95  L7.  E15  J5.  M1)  J15
     K95  M7.  E15  A5.  M95  H15
     K95  C7.  H15  A5.  M95  H15
     H95  D7.  H15  A5.  M53  E15
     F15  L1!  E1!  J.5  122  A1!
     E1!  M1!  E1!  J.5  120  A1!

B    C40  C1.  M0-  F2.  1M-  F2.
     C40  J1.  M0-  F2.  M0-  E2.
     H40  M10  M0-  A2.  A15  F2.
     H40  M10  M0-  A5.  A10  J2.
     L7.  L1$  E1!  J5.  A1!  A1!
     L7.  0!$  E1!  J5.  1A!  F1!

B    F2.  E1)  M2.  C13  F52  M0-
     E2.  F1!  M2.  C13  F52  M0-
     F2.  H1)  K2.  K15  F52  00-
     J2.  E1)  J2.  H13  A52  M0-
     A1!  C1!  A1!  E15  :!!  H1!
     A1!  M1!  F1!  E15  :!!  E1!

B    M0-  J5.  J2.  F52  F2.  H13
     M0-  J5.  J2.  F52  F2.  010
     M0-  F5.  F2.  J52  J2.  H10
     M0-  J5.  F5.  F52  F2.  K15
     01!  M.2  A2.  A!!  A!!  A!5
     01!  R.2  A5.  A!!  J!!  E15

B    JF.  M0-  H5)  M2.  M2.  F52
     JF.  M0-  H5)  M5.  M2.  F52
     FJ.  00-  A5)  J2.  F2.  J52
     KH.  00-  A5)  J5.  F5.  F52
     H.J  H11  115  J2.  J2.  H11
     HJ!  H11  115  F5.  J5.  H11

B    J1.  J1.  J5.  H30  L70  F2.
     F1.  F1.  J5.  H30  L70  EE2.
     E10  E1.  H5.  H30  004  F2.
     A10  F1.  H5.  H30  004  J2.
     C1$  A1!  J.5  :!!  L.0  A52
     0!$  A1!  F.5  L!!  L.0  F52

B    M1-  M2.  L10  M0-  K13  R2.
     M1-  M2.  L10  00-  F13  R2.
     01-  J2.  010  T0-  H13  R2.
     M1-  J2.  L10  00-  F15  M2.
     M1!  F1!  L1!  H-0  J15  J1!
     M1!  F1!  L1!  H-0  H15  F1!

B    LH.  R2.  M0-  F1.  M1.  H5-
     LH.  D2.  M0-  :!!  C1.  H5-
     HL1  R2.  M0-  :!!  C1.  A5-
     HL1  M2.  M0-  :!!  C1.  A5-
     LH.  J.5  H-5  :!!  L!!  H-0
     LH.  F.5  H-5  :!!  L!!  H-0

B    F52  H5-  M2.  M0-  K13  L7.
     F52  H5-  M2.  M0-  J13  07.
     J52  H5-  F2.  M0-  H10  07.
     J52  H5-  F2.  00-  H10  07.
     A!!  0!.  J.5  H-0  H15  L7
     A!!  0!.  J.5  H-0  H15  0.7

B    HE)  M0-  L7.  J5.  L7.  F52
     HE)  L.0  L7.  J5.  L7.  F52
     H5)  M0-  07.  J5.  C7.  F52
     05)  M0-  07.  A5.  C7.  A52
     HE-5  F2.  M.2  A5.  L7.  J1!
     H15  A-5  H.7  H.2  L.7  J1!

B    J1.  L1.  C1.  J5.  K73  HE.
     H1.  D1.  C1.  M5.  K73  F0.
     J1.  D1.  F10  M5.  K73  C0
     H1.  L1.  F10  M5.  K73  EA0
     H1.  F1$  M.2  E15  E10  F0$
     H1!  L1!  C!$  R.2  H15  C0$

B    K95  HE5  H13  H40  J1.  J2.
     K95  HE5  K13  C40  01.  F2.
     H95  EH!  K13  L40  010  J2.
     H95  EH!  K13  L40  010  J2.
     E1!  HE5  H11  01!  L1$  H1!
     E1!  HE!  E15  L1!  0!$  H1!

B    T40  M5-  M0-  H15  F12  E1)
     T40  M5-  L0-  H15  M12  H1)
     040  M5-  0-0  E1)  F12  H1)
     L40  M5-  0-0  E1)  J12  H1)
     H.4  H1!  M5-  A!!  J!.  H1!
     C.4  H1!  M5-  A!!  J!.  H1!

B    00-  JF5  M5-  CC.  L0.  LC$
     M0-  JF5  M5-  JC.  L0.  HC0
     L-0  HE)  M5-  HE0  L0.  L1/
     H-0  EA)  M5-  FC0  H0.  L10
     M5-  AE!  E1!  EH$  00.  L1/
     M5-  AE!  M1!  C0$  00.  L10

B    M1-  C4.  M5-  F2.  M0-  H13
     0!-  C4.  J5-  F2.  M0-  K13
     M1-  C.4  M5-  A2.  M0-  K13
     0!-  H.4  M5-  A2.  E0-  H13
```

(listing continued on page 59)

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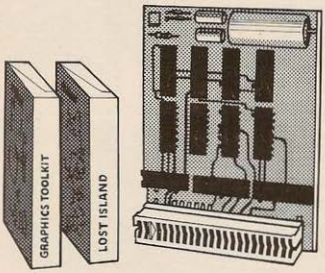

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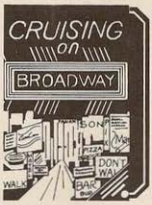

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(continued from page 57)

the beginning of a tape by typing:

```
SAVE "MINUETZ"LINE 1
```

This allows it to AutoRun on loading, Line 1 fetching the tables and machine code from their final position on the tape immediately following the Basic.

Second, the bar table, figure 2, embodies the main data bank of the program, holding Mozart's 176 bars. 18 bytes of RAM are used to store the information for one bar. Since all of them are in three-eight time, and since the shortest note used was a semiquaver, the obvious time-slot of a sixth of a bar was chosen as the building block of the music. There is, in fact, one byte per channel per time slot. Figure 2 reveals something of the identity of the data by grouping them in bar "dominoes", with one time slot occupying a single domino row.

Using ASCII characters to represent the bytes has allowed a very compact table with a meaningful appearance and easy points of entry. Use the routine given at the end of figure 2 to enter the data. It mimics the printed listing on the screen as the bytes — in the form of strings — are entered, and allows you to start at any row of dominoes. If you wish to save the code at some stage prior to having entered it completely, type:

```
SAVE "MINUETZCODE"CODE 28930,3642
```

Before entering any code at all, always type Clear 28929. To continue with a half-entered table, type Clear 28929, Load in the code from tape, and again use the routine at the foot of figure 2, returning the appropriate bar to the prompt.

Third the machine-code routines and tables — figure 3. Having completed the bar table and Saved it on tape, type in the little loader at the end of figure 3. Type Clear 28929, and Load in the bar table, since the material in figure 3 will be part of the same 3,642-byte block of RAM. Run the figure 3 loader, and enter each block in turn, making sure you get the start address right, and of course, the number of bytes. The start address is the first address given under each block and the number of bytes is clearly marked.

Follow the same procedure used for figure 2 to save intermediate stages. Note that the figure 3 loader also mimics the layout of the printout on the screen to make checking of entries easier.

In the Basic program, lines 36-200 encompass the dice loop, generating the random numbers for the dice and drawing the dice themselves in their first two positions. But as you might imagine, there is a fair amount of work involved in drawing the dice. This could be handled only with the aid of machine code, which had the added advantage of economising on rapidly shrinking text-space. It may be of interest to point out that the final dice are drawn initially in "invisible" ink; this avoids flicker since the operation of converting the ink colour is a lot quicker than that of performing the calculations and drawing the dice with dots. Machine-code routines used are Dicemain, Drawdice and Prtdots, with their associated tables. Another subterfuge used for reasons of speed is that the monitor Circle routine is avoided.

Line 9890 — this short subroutine is called after the dice have been thrown to convert the

(continued on next page)

(listing continued from page 57)

```
H!!  L7-  F!!  J!!  A-0  E!5
D0   L7-  E!!  H!!  A-0  H!!
H!0  L7-  E!!  H!!  A-0  H!!
H!!  M0-  H!.  K!3  FA-  H!.  H!!
M0-  H!.  H!3  FA-  C!.  G!.
LH.  O!0  C!3  J!.  L!.  H!.
LH.  M0   C!3  K!0  M!.  H!!
OL.  O!$  E!5  J!2  O!!  O!!
OL.  L!$  E!5  K!4  L!!  L!!

M0-  F52  E!.  J!.  F2.  M0
D0   A52  E!!  H!.  E2.  H!!
M0-  J52  H!!  H!0  F2.  M0.
H!0  H52  H!!  E!$  J2.  M0
E!!  H!!  C!!  E!$  A-2  M0
E!!  H!!  H!!  C!$  F-2  H!!

M0-  H!5  H!-  H95  F2.  M2.
L0-  H!4  H!-  O95  F2.  M2.
M0-  A!5  E!-  H95  F2.  M2.
M!0  A!0  E!-  H95  M2.  J2.
E!!  A!-  A!!  E!!  J!!  H!!
E!!  A!!  A!!  E!!  J!!  H!!

J!.  E5)  K!3  A2.  J!5  D0-
M!.  F5)  O!3  A5!  F!5  M0-
M!0  H5!  C!3  F2.  E!!  D0-
M!0  J5)  C!3  F5!  H!!  M0-
C!$  K-5  E!5  J2.  M!!  H-0
L!$  H-5  H!5  J5!  H!!  H-0
```

ENTER THE ABOVE TABLE USING THE FOLLOWING ROUTINE.NOTE THAT EACH DOMINO OF CHARACTERS REPRESENTS ONE BAR.AND THAT THE CHARACTERS ARE ENTERED AS 6,THREE-CHARACTER STRINGS,TAKEN FROM ROUS 1 TO 5 OF THE DOMINO IN TURN.
N.B. IF INVERTED COMMAS APPEAR IN A STRING.SIMPLY TYPE THEM TWICE.A THE COMPUTER WILL READ IT AS ONE SET

```
  2 POKE 23658,12: CLS : INPUT
"STARTING BAR ?";B: LET P=2891
"2+5B+1
  4 FOR N=5B TO 133 STEP 6: PRI
NT INVERSE 1;N;: FOR B=0 TO 5: F
OR R=0 TO 5
  6 INPUT "3-CHAR STRING ";A$:
IF LEN A$<>3 THEN INPUT FLASH 1;
"ERROR:PRESS ENTER ";A$: GO TO 6
  8 FOR K=0 TO 2: POKE P+K+R*3,I
N+CODE A$(K+1)-33: NEXT K: PR
INT AT 0+R,4+B*5;A$
  10 NEXT R: NEXT B: INPUT "NEXT
 SET OF BARS (Y/N)? ";A$: IF A
$="Y" THEN LET P=P+108: CLS : NE
XT N
  12 STOP
```

Figure 3.

```
NOTETABLE (104 BYTES)

31414 0   0   148 6   42  6
31420 210 5   186 5   47  5
31426 229 4   158 2   92  4
31432 29  4   226 3   171 3
31438 3   2   241 1   21  3
31444 233 2   191 2   152 2
31450 114 2   79  2   46  2
31456 15  2   241 1   213 1
31462 177 1   162 1   139 1
31468 116 1   96  1   76  1
31474 57  1   40  1   23  1
31480 7   1   249 0   255 0
31486 221 0   209 0   197 0
31492 186 0   176 0   166 0
31498 157 0   148 0   140 0
31504 132 0   125 0   117 0
31510 111 0   105 0   99  0
31516 93  0   0

DICETABLES (176 BYTES)

31518 21  6   62  36  66  85
31524 39  95  34  3   12  21
31530 5   62  16  85  39  91
31536 47  112 75  12  111 102
31542 123 91  127 85  94  92
31548 38  129 97  57  58  13
31554 73  41  131 49  46  122
31560 54  84  86  115 119 126
31566 71  120 61  110 67  107
31572 15  99  42  58  2   60
31578 61  105 74  103 43  93
31584 11  106 90  124 59  95
31590 29  133 93  116 57  97
31596 29  5   29  5   29  5
31602 29  5   29  5   29  94
31608 59  78  83  108 13  97
31614 98  63  111 92  25  109
31620 138 113 64  121 76  69
31626 4   19  24  101 14  7
31632 57  116 45  44  18  26
31638 86  9   51  104 38  100
31644 27  137 130 6   128 75
31650 45  136 52  68  68  82
31656 59  47  94  53  13  45
31662 17  52  125 66  82  152
31668 47  34  53  12  99  93
31674 114 48  1   92  77  65
31680 117 135 40  8   8   8
31686 8   8   8   8   70  70
31692 70  8

DRAUDICEDATA1 (252 BYTES)

31694 17  26  16  31  18  21
31700 16  31  17  26  18  21
31706 18  31  20  27  18  21
31712 14  25  16  31  20  27
31718 18  21  14  25  17  26
31724 16  31  16  29  20  27
31730 18  21  16  23  14  25
31736 11  29  10  32  11  25
31742 10  32  11  29  11  26
31748 10  32  14  32  14  32
31754 7   26  10  32  14  32
31760 11  25  7   26  11  29
31766 14  32  12  32  14  32
31772 11  26  9   26  7   26
31778 12  32  9   24  16  20
31784 8   24  16  20  12  24
31790 8   24  12  24  16  20
31796 12  20  8   24  15  24
31802 16  20  12  20  12  22
31808 8   24  10  24  13  24
31814 16  20  14  20  12  20
31820 14  9   13  14  15  4
31826 13  14  14  9   15  4
31832 13  14  17  10  15  4
31838 13  8   13  14  17  10
31844 15  4   11  8   14  9
31850 13  14  15  12  17  10
31856 15  4   13  6   11  8
31862 9   12  7   15  8   6
31868 9   15  6   9   6   12
31874 7   15  11  15  6   15
31880 4   9   9   6   11  15
31886 9   9   4   9   6   12
31892 7   15  8   15  11  15
31898 8   9   8   9   4   9
31904 9   5   7   13  7   13
31910 5   7   13  3   9   5
31916 5   7   9   7   13  9
31922 9   3   7   9   7   9
31928 13  3   9   3   9   5
31934 9   7   7   9   9   5
31940 13  3   11  3   9   3

DRAUDICEDATA2 (12 BYTES)

31946 5   4   6   3   6   5
31952 5   1   5   6   4   1

DRAUDICEDATA3 (40 BYTES)

31958 47  45  1   1   65  22
31964 1   255 47  47  255 255
31970 255 255 1   255 1   1
31976 0   255 55  25  1   255
31982 0   55  1   1   0   55
31988 0   255 45  45  1   1
31994 0   55  0   1

DICEMAIN (102 BYTES)

31998 253 54  55  0   33  205
32004 123 55  55  159 125 6
32010 197 229 245 205 129 125
32016 1   49  0   241 225 33
32022 229 17  200 124 19  19
32028 61  32  251 26  213 205
32034 129 125 209 19  16  7
32040 42  0   0   225 25  229
32046 205 129 125 209 225 25
32052 56  160 125 193 16  205
32058 33  140 80  34  126 52
32064 205 129 125 33  4   126
32070 34  125 92  205 126 125
32076 253 34  125 33  0   0
32082 88  1   192 2   126 254
32088 0   52  2   126 7   11
32094 35  120 177 32  243 201

DRAUDICE (29 BYTES)

32100 217 229 217 6   10  33
32106 214 124 197 78  35  78
32112 35  94  35  86  35  220
32118 205 156 36  225 193 16
32124 239 217 225 217 201

PRTDOTS (30 BYTES)

32129 71  197 175 87  95  121
32135 26  28  16  251 25  25
32141 193 197 70  35  78  35
32147 229 205 217 13  62  111
32153 215 225 193 16  240 201

NATTABLE (51 BYTES)

32225 1   1   2   2   3   4
32231 4   5   5   6   7   7
32237 8   8   9   9   10  11
32243 11  12  12  13  13  14
32249 14  15  16  16  17  18
32255 18  19  19  20  20  21
32261 22  22  23  23  24  25
32267 25  26  26  27  27  28
32273 29  29  30

NOTESORT (74 BYTES)

32276 17  161 125 213 33  209
32282 125 6   6   197 24  18
32288 229 213 33  240 112 17
32294 18  0   25  16  255 209
32300 6   6   126 35  35  35
32306 18  19  16  240 225 193
32312 16  227 225 6   48  197
32318 126 6   51  104 40  6
32324 16  251 175 119 24  15
32330 17  224 128 19  16  253
32336 26  119 27  26  190 32
32342 2   203 254 55  193 16
32348 224 201

PLAYMAIN (77 BYTES)

32350 6   2   197 197 6   6
32355 17  209 128 197 26  19
32362 213 71  33  0   0   77
32368 18  0   25  16  253 1
32374 240 112 167 91  6   6
32380 197 205 171 126 6   121
32386 1   253 1   32  1   253
32392 249 193 16  240 209 193
32398 16  215 0   20  14  255
32404 13  32  253 18  209 193
32410 16  197 33  101 126 54
32416 217 193 16  54  209
32422 201 197 4   24  182

PLAYSLOT (38 BYTES)

32427 175 245 211 221 175 190
32433 32  6   205 209 126 175
32439 24  14  70  17  182 182
32445 19  19  16  252 25  19
32451 205 209 126 25  205 209
32457 126 35  241 254 5   200
32463 24  219

OUT (22 BYTES)

32465 6   1   16  254 211 223
32471 6   1   16  254 193 241
```

(listing continued on next page)

(continued from previous page)

dice numbers into equivalent bar numbers.

Lines 9916-9925 draw the blank manuscript, and lines 8530-8775 — see figure 6 — actually print out the music. Each voice is printed out in full before moving on to the next voice. The appropriate data is fetched from the bar table by the machine-code routine Notesort. Lines 8771-8775 actually print the notes, U being a flag to determine the direction in which the tails are drawn, Z being another flag indicating whether leger lines are required.

Line 9900 is a subroutine to print out the record of dice numbers.

Lines 9800-9835 play the music. The PSG is initialised in Basic before calling the machine code which actually outputs the music. The first entry point to the subroutine is at line 9830, the routine re-entering itself from line 9800 if a repeat is desired. Which machine-code routines are called depends on whether a PSGIO board is connected. If it is then Playmain is called, which in turn uses Playslot and Out. If no soundboard is detected then Musicbox is called, which simulates a musical box playing through the top voice only; even the clicks of the wards are included. Seriously though, the Musicbox routines — including Part and Beepout — are really only intended to verify the software as a whole if you have not yet got hold of a PSGIO board, and though fun, is no substitute for the real, three-voice original. On the PSGIO board, an output socket is provided to allow you to plug into the Aux input of your amplifier: this arrangement really does justice to the music.

Lines 207-253 call the manuscript drawing and play subroutines when required, and handle Saving of manuscript, as well as setting up volume and tempo variables.

Line 253 changes key each cycle, according to the factor KY.

Finally, a note on I/O: the two registers, 14 and 15 in the PSG give 16 bits of TTL-compatible I/O capability to the PSGIO circuit. As pointed out earlier, the ports can be driven completely independently of the sound generation; while sound is being output, I/O operations can be performed. The ports are bidirectional. Bits 6 and 7 of register 7 are used to dictate which direction is operational for each port; if either is set to one then the corresponding port is in output mode, if a zero setting, then the port is in input mode. The possibilities are endless.

There is nothing to stop anyone substituting his own bars for the Mozart using the information given in the text, and with the limitations that with the current arrangement only triple-time music can be accommodated.

Those familiar with machine code should find it relatively easy to cope with duple times by changing the number of slots and the cycle counters which handle them.

Some programmers will be unwilling or unable to deal with the effort of punching in the whole of Minuet2, or building the programmable sound generator and input/output board. If they wish, they may write to Rod Hopkins at 5 Greenside, Leslie, Fife KY6 3DD for a copy of the program at £3.25, or the fully-built PSGIO board together with the program for £19.75. Both prices include postage and packing.

(listing continued from previous page)

```
32477 60   211 221 245 197 6
32483 1    16  254 201

MUSICBOX (25 BYTES)

32487 6    2   197 62  225 167
32493 214  3   16  252 50  25
32499 126  205 0   127 193 16
32505 239  62  209 50  25  126
32511 201

PART (23 BYTES)

32512 33   59  126 54  201 229
32516 205  28  126 205 23  127
32524 6    255 16  254 205 23
32530 127  225 54  6   201

BEEPOUT (36 BYTES)

32535 33   161 125 6   48  197
32541 229  239 62  128 17  0
32547 0    24  62  225 126 35
32553 254  9   32  2   62  69
32559 229  205 40  45  205 240
32565 3    225 193 16  226 201


ENTER EACH OF THE ABOVE DUMPS IN
 TURN USING THE FOLLOWING ROUT-
INE. IN EACH CASE THE START
ADDRESS IS THE FIRST ADDRESS
SHOWN FOR THAT DUMP

   2 INPUT "NUMBER OF BYTES ? ";
B: INPUT "START ADDRESS ? ";S
   4 FOR N=S TO S+B-1 STEP 8: PR
INT N; FOR K=0 TO 5
   6 INPUT "NEXT BYTE ? ";A: POK
E N+K,A: PRINT TAB 6+K*4;A; IF
N+K=S+B-1 THEN GO TO 10
   8 NEXT K: PRINT : NEXT N
  10 STOP
```

Figure 4.

```
MACHINE CODE DISSASSEMBLY
"DICEMAIN"
INKOFF    LD(ATT-T),0
          LD HL,DATA1
          LD A,(LMDICENO)
          LD E,DICE COUNT
NXTDICE   PUSH BC
          PUSH HL
          PUSH AF
PRTOPFACE CALL PRTDOTS
          LD DE,FACESTEP
          POP AF
          POP HL
          ADD HL,DE
          PUSH HL
          LD DE,DATA2-2
VALIDNUM  INC DE
          INC DE
          DEC A
          JRNZ VALIDNUM
          LD A,(DE)
          PUSH DE
PRTLHFACE CALL PRTDOTS
          POP DE
          INC DE
          LD A,(DE)
          LD DE,FACESTEP
          POP HL
          ADD HL,DE
          PUSH HL
          PUSH DE
PRTRHFACE CALL PRTDOTS
          POP DE
          POP HL
          ADD HL,DE
          LD A,(RHDICENO
          POP BC
          DJNZ NXTDICE
DRAWCUBES LD HL,RHPLOTCORDS
          LD(PLOTXY),HL
          CALL DRAWDICE
          LD HL,LHPLOTCORDS
          LD(PLOTXY),HL
          CALL DRAWDICE
INKON     LD(ATT-T),7
          LD HL,ATT-FILE
          LD BC,SCRNSIZE
NXTPOSN   LD A,(HL)
          CP INK0
          JRNZ DONE?
          LD(HL),INK7
DONE?     DEC BC
          INC HL
          LD A,B
          OR C
          JRNZ NXTPOSN
          RET
"DRAWDICE"
SAVERET   EXX
          PUSH HL
          EXX
          LD B,SIDECOUNT
          LD HL,DATA3
NXTSIDE   PUSH BC
          LD C,(HL)
          INC HL
          LD B,(HL)
          INC HL
          LD E,(HL)
          INC HL
          LD D,(HL)
          INC HL
          PUSH HL
          CALL DRAW
          POP HL
          POP BC
          DJNZ NXTSIDE
UNSTKRET  EXX
          POP HL
          EXX
          RET
```

```
"PRTDOTS"
GETNUM    LD B,A
          PUSH BC
          XOR A
          LD D,A
          LD E,A
GETDOTPAT ADD A,E
          INC E
          INC E
          DJNZ GETDOTPAT
          LD E,A
          ADD HL,DE
          POP BC
NXTDOT    PUSH BC
          LD B,(HL)
          INC HL
          LD C,(HL)
          INC HL
          PUSH HL
          CALL SETPRTPOS
          LD A,CODE "o"
PRTDOT    RST 10H
          POP HL
          POP BC
          DJNZ NXTDOT
          RET
"NOTESORT"
          LD DE,VOICESTO
          PUSH DE
          LD HL,RNDTABLE
          LD B,BARCOUNT
NXTBAR    PUSH BC
          LD B,(HL)
          INC HL
          PUSH HL
          PUSH DE
          LD HL,BARTABLE-18
          LD DE,BARSTEP
GETBAR    ADD HL,DE
          DJNZ GETBAR
          POP DE
          LD B,SLOTCOUNT
NXTSLOT   LD A,(HL)
          INC HL
          INC HL
          INC HL
          LD (DE),A
          INC DE
          DJNZ NXTSLOT
          POP HL
          POP BC
          DJNZ NXTBAR
          POP HL
          LD B,BARS+SLOTS
NXTSLOT   PUSH BC
          LD A,(HL)
          LD B,TOPNOTE
NOTE?     CP B
          JRZ NATEQUIV
          DJNZ NOTE?
          LD A,B
          LD(HL),A
          JR PTNXTSLOT
NATEQUIV  LD DE,NATTABLE-1
GETNAT    INC DE
          DJNZ CALCNAT
          LD A,(DE)
          LD(HL),A
          DEC DE
          LD A,(DE)
          CP (HL)
          JRNZ PTNXTSLOT
          SET 7,(HL)
PTNXTSLOT INC HL
          POP BC
          DJNZ NXTSLOT
          RET
"PLAYMAIN"
          LD B,PARTCOUNT
          PUSH BC
REPEAT    PUSH BC
          LD B,BARCOUNT
          LD DE,RNDTABLE
NXTBAR    PUSH BC
          LD A,(DE)
          INC DE
          PUSH DE
          LD B,A
          LD HL,0
          LD DE,18
          ADD HL,DE
CALCBAR   DJNZ CALCBAR
          LD BC,BARTABLE-18
          AND A
          ADD HL,BC
          LD B,SLOTCOUNT
NXTSLOT   PUSH BC
          CALL PLAYSLOT
          LD B,COUNT1
LOOP1     LD C,COUNT2
LOOP2     DEC C
          JRNZ LOOP2
          DJNZ LOOP1
          POP BC
          DJNZ NXTSLOT
          POP DE
          POP BC
          DJNZ NXTBAR
          LD B,COUNT1
LOOP3     LD C,COUNT2
LOOP4     DEC C
          JRNZ LOOP4
          DJNZ LOOP3
          POP BC
          DJNZ REPEAT
          LD HL,RANDTABPOINT
          LD (HL),PART2POINT
          POP BC
          DJNZ REPEAT2
          LD (HL),PART1POINT
          RET
REPEAT2   PUSH BC
          INC B
          JR REPEAT
"PLAYSLOT"
NXTVOICE  XOR A
          PUSH AF
          OUT REGADDR,A
          XOR A
          CP (HL)
          JRNZ GETNOTE
          CALL OUT
          XOR A
          JR HIOUT
          LD B,(HL)
```

```
CALCNOTE    LD DE,NOTETABLE-2
            INC DE
            INC DE
            DJNZ CALCNOTE
            LD A,(DE)
            INC DE
            CALL OUT
            LD A,(DE)
MIOUT       CALL OUT
            INC HL
            POP AF
            CP 6
            RET Z
            JR NXTVOICE

"OUT"
            LD B,COUNT
LOOP1       DJNZ LOOP1
            OUT 253,A
            LD B,COUNT
LOOP2       DJNZ LOOP2
            POP BC
            POP AF
            INC A
            OUT 221,A
            PUSH AF
            PUSH BC
            LD B,COUNT
LOOP3       DJNZ LOOP3
            RET

"MUSIC BOX"
            LD B,2
NXTPART     PUSH BC
            LD A,255
            AND A
GETPART     SUB 8
            DJNZ GETPART
            LD(RNDTABLO),A
            CALL PART
            POP BC
            DJNZ NXTPART
            LD A,RNDTLO
            LD(RNDTABLO),A
            RET

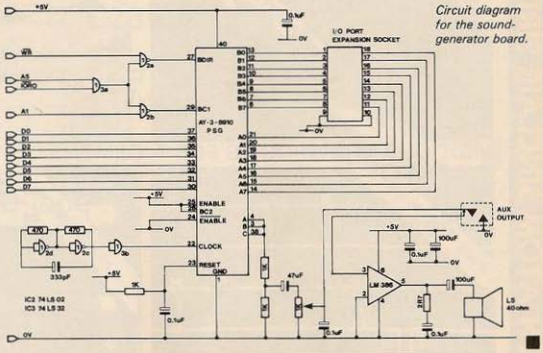
"PART"
            LD HL,NOTESORTEND
            LD(HL),RET
            PUSH HL
            CALL NOTESORT
            CALL BEEPOUT
            LD B,COUNT
LOOP1       DJNZ LOOP1
            CALL BEEPOUT
            POP HL
            LD(HL),"LD,B"
            RET

"BEEPOUT"
            LD HL,VOICESTO
            LD B,SLOTS
NXTSLOT     PUSH BC
            PUSH HL
            RST 28H
            DEFB
            DEFB
            DEFB
            DEFB
            DEFB
            DEFB
            DEFB
            POP HL
            LD A,(HL)
            INC HL
            CP NONOTE
            JRNZ NOTE
            LD A,NONOTE
NOTE        PUSH HL
            CALL STKACC
            CALL ROMBEEP
            POP HL
            POP BC
            DJNZ NXTSLOT
            RET
```

Figure 5.

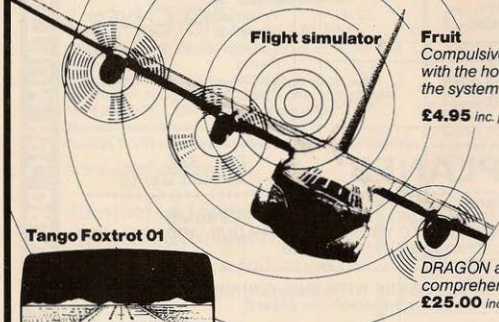
RAM ALLOCATIONS ABOVE RAMTOP

26930-31413	BARTABLE
31414-31517	NOTETABLE
31518-31693	DICETABLES
31694-31997	DRAUDICEDATA
31998-32099	DICEMAIN
32100-32128	DRAUDICE
32129-32158	PRTDOTS
32159-32160	DICENOSTO
32161-32208	VOICESTO
32209-32224	RNDTAB
32225-32275	NATTABLE
32276-32349	NOTESORT
32350-32426	PLAYMAIN
32247-32464	PLAYSLOT
32465-32486	OUT
32487-32511	MUSICBOX
32512-32534	PART
32535-32570	BEEPOUT



Circuit diagram for the sound-generator board.

DRAGON 32 Cassettes



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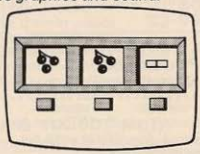

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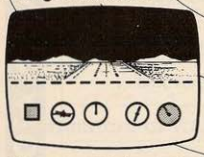

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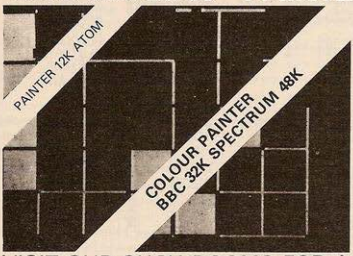

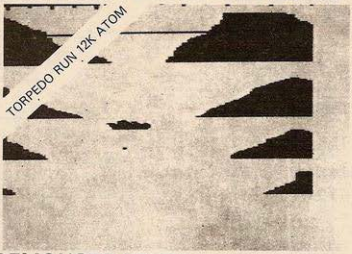

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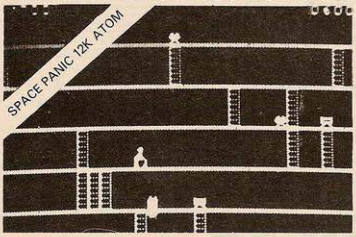

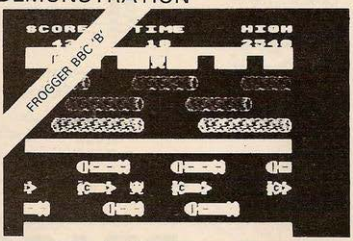

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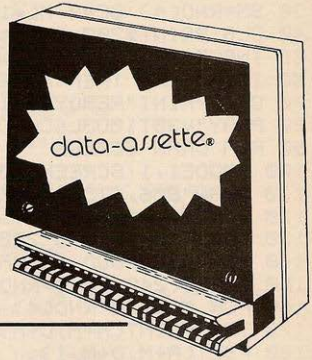

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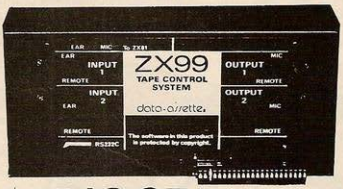

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```
10 REM MAGGOTS (C) M.PERCY JAN'83
20 CLEAR 2000:X=128:Y=96:I=128:O=96
30 SM=RND(4):SC=0:ML=10
40 CLS:PRINT@200,"ma99ots"
50 INPUT "FAST OR SLOW(F/S)";S$
60 IF S$="F" THEN POKE &HFFD7,0
70 CLS:PRINT"READY!!";
80 PLAY"V30T1003L6CL302GGL2EEL1CC":CLS
90 REM DRAW SCREEN
100 PMODE1,1:SCREEN1,0:PCLS2:COLOR4,2
110 DRAW"BM6,6;C4;R243D180L243U180"
120 PAINT(0,0),4,4
130 GOSUB 150:GOTO 220
140 REM PUT FOOD IN RANDOM POSITION
150 A=RND(240)+8:D=RND(178)+8
160 FOR M=1 TO RND(4)
170 IF PPOINT(A+M,D+M)=4 THEN 150
180 PSET(A+M,D+M,1)
190 SOUND 100,1
200 NEXT M
210 RETURN
220 REM MOVEMENT
230 ON SM GOTO 290,360,430,500
```

Fast and tricky, M Percy's Maggots will soon have you wriggling at the keyboard.

THIS ADDICTIVE high-resolution game for the Dragon 32 does wonders for the reflexes and gets away from the era of laborious games with a ready-set maze.

Due to the amazing speed with which the Dragon works in Basic, this game — in which a red maggot runs around the screen and searches for food — can be very hard. A speed option is offered: this is done by setting the internal timer to a running speed of 1.8 MHz instead of the default of 0.9 MHz.

The idea is to move the maggot — which starts off in a random direction, but always from the centre position — round the screen, to the clumps of food which are represented by green dots. Movement is achieved by the use of the arrow keys. When a clump of food is eaten the maggot increases by a length or two.

Turning should be kept to a minimum because the maggot sloughs its skin. If the maggot hits this or the border then the game is lost. As more and more corners are turned the screen fills up with red lines. The bigger the maggot the longer the barricade of dead skin will be.

When the maggot has reached a length of 40 the game stops for five seconds. The screen then clears and play starts again, but instead of starting off 10 segments long, it starts with two so that more epithelia will be descarded, making the game harder than before. When three sets have been cleared the internal timer is set to Fast mode so that the game, if started in Slow, will now be fast. The game then continues with a new set appearing each time the maggot attains a length of 40 units.

Due to the way the end of the maggot is preset to keep it at the length specified by ML and the variables I and O a skin or skin segment immediately behind the maggot may disappear. This will only happen when turning and may be used to an advantage to reach food which was inaccessible — but be careful that the food is not erased as well.

Lines 20-30 clear room for the strings and set all necessary variables; lines 50-60 determine speed; and lines 70-120 set display.

In line 130, the Gosub moves to the food routine: the Goto is for starting the game.

Lines 150-200 place a clump of food in a random position with line 170 checking to see if the point is already set to read, and if so starts the routine again. Up to four blocks of food may appear in one clump or as little as one — variable M determines this. Line 150 places the food in the yellow area of the screen only. Line 230 starts the maggot moving in the appropriate random direction by the variable SM, and goes to the appropriate line number; lines 240-280 send control to the appropriate line number, and line 290 checks to see if any of the arrow keys have been depressed.

If none has been depressed or if the reverse key has been pressed, then the maggot carries on moving in the same direction or else goes

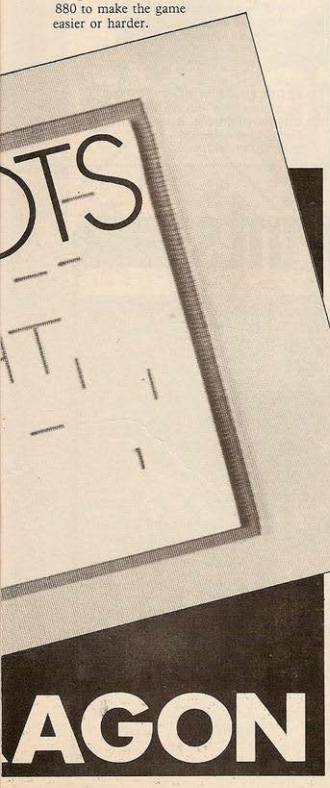
back to lines 240-280 for the next direction.

Line 300 checks to see if the next point to be PSet is red and if so moves the losing routine at 580. Line 310 checks to see if the next point is food and if so goes to the appropriate routine.

Lines 330-350 subtract the length of the maggot from the PSet position and preset these points so that the maggot does not appear as one continuous line.

Line 590 speeds the routine up and 700 slows it back down. Lines 790-850 search for food in an area of three by three around the maggot's head and for each little block found five points are added to the score. Line 840 then presets these points so that no food is left in that area. Line 860 goes to the routine for placing some more food in another random position. Line 870 adds two to the length of the maggot. Line 880 checks to see if it is 40 in length and if so goes to the routine at 900.

Lines 900-950 clear the screen and add 1 to the amount of sets cleared. Line 940 makes the game fast if a fourth set is reached. Line 950 gives the maggot a length of two and continues the game. Variable ML can be changed in line 880 to make the game easier or harder.



(continued from facing page)

```
240 IF B$=CHR$(94) THEN 290
250 IF B$=CHR$(10) THEN 360
260 IF B$=CHR$(8) THEN 430
270 IF B$=CHR$(9) THEN 500
280 GOTO 240
290 B$=INKEY$:IF B$=CHR$(10) OR B$="" THEN Y=Y-2 ELSE 240
300 IF PPOINT(X,Y)=4 THEN 580
310 IF PPOINT(X,Y)=1 THEN GOSUB 780
320 PSET(X,Y,4)
330 I=X:O=Y+ML:IF O>184 THEN O=184
340 PRESET(I,O)
350 GOTO 290
360 B$=INKEY$:IF B$=CHR$(94) OR B$="" THEN Y=Y+2 ELSE 240
370 IF PPOINT(X,Y)=4 THEN 580
380 IF PPOINT(X,Y)=1 THEN GOSUB 780
390 PSET(X,Y,4)
400 I=X:O=Y-ML:IF O<8 THEN O=8
410 PRESET(I,O)
420 GOTO 360
430 B$=INKEY$:IF B$=CHR$(9) OR B$="" THEN X=X-2 ELSE 240
440 IF PPOINT(X,Y)=4 THEN 580
450 IF PPOINT(X,Y)=1 THEN GOSUB 780
460 PSET(X,Y,4)
470 I=X+ML:O=Y:IF I>242 THEN I=242
480 PRESET(I,O)
490 GOTO 430
500 B$=INKEY$:IF B$=CHR$(8) OR B$="" THEN X=X+2 ELSE 240
510 IF PPOINT(X,Y)=4 THEN 580
520 IF PPOINT(X,Y)=1 THEN GOSUB 780
530 PSET(X,Y,4)
540 I=X-ML:O=Y:IF I<8 THEN I=8
550 PRESET(I,O)
560 GOTO 500
570 REM PRINT SCORES
580 FOR Z=0 TO 250:NEXTZ
590 POKE &HFFD6,0
600 FOR C=1 TO 4
610 PLAY"V31T20001CDECDECDE"
620 DRAW"C"+STR$(C)
630 DRAW"BM120,100;S8;R5U5L5U5R5"
640 DRAW"BM137,100;S8;U10R5D5L5"
650 DRAW"BM152,100;S8;NR5U10"
660 DRAW"BM166,100;S8;U10R5D10U5L5"
670 DRAW"BM180,100;S8;BR5U10NL5R5"
680 NEXT C
690 SOUND 1,20
700 POKE &HFFD6,0
710 FOR Z= 0 TO 100:NEXTZ
720 CLS:PRINT"YOUR BODY WAS";ML;"CMS LONG,"
730 PRINT"AND YOU SCORED";S;"POINTS."
740 PRINT"AND CLEARED";SC;"SETS"
750 INPUT"ANOTHER GO(Y/N)";B$
760 IF B$="N" THEN END
770 RUN
780 REM SEARCH FOR FOOD
790 FOR B=-2 TO 2
800 FOR V=-2 TO 2
810 IF PPOINT(B+X,V+Y)=1 THEN 820 ELSE 850
820 SOUND 230,1
830 S=S+5
840 PRESET(B+X,V+Y,2)
850 NEXT V,B
860 GOSUB 150
870 ML=ML+2
880 IF ML=40 THEN 900
890 RETURN
900 FOR Z=0 TO 600:NEXT Z
910 CLS:PRINT"ANOTHER SET COMING UP"
920 PLAY"V3101DDDO2CDEFGO2CDEFG"
930 SC=SC+1
940 IF SC=3 THEN POKE &HFFD7,0
950 ML=2:GOTO 100
```

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FORTH: ACE

WITH FORTH now available for home computers and the release of the Jupiter Ace, users suddenly have a machine and a language ideally structured to games that are fast, involved and without the relative complexity of machine code. Forth's compact programming means one can develop and test each of the elements of the whole program as one builds it up.

The disadvantage of not being able to code from the top down, as in Basic, is overcome easily by either flowcharting the proposed program or doing a simple logical list of its component parts.

The Jupiter Ace I used for this program has an actual memory availability for user Forth words of less than 1K. This may seem very little but it gives one sufficient space to create versions of popular arcade games that contain the main features of the originals and run very close to their speeds. In fact, I found that Pac-Man written in Forth actually runs faster than the game played at the local amusement centre. As it is one of the more popular games and contains many of the building blocks one would use in other games I chose it as the example for this article.

I have included all the main points of the arcade version, except for the power pills which would take up an extra 500 bytes at a rough estimate.

I have assumed that you understand the basic words used in the Ace but include an explanation of the specific techniques involved. To conserve memory the variables and words used have short names but I comment on each separately.

The sequence for the game is as follows. First, the graphics used for the man, ghosts, dots and wall are defined and the screen created. Next the variables are initialised and the man and ghosts placed in their starting positions.

The way the man moves is broken down into the following steps. First, a check to see if an appropriate key has been pressed, and the program continues with this sequence if it has.

The Inkey function on the Ace returns to the stack the ASCII value of the key pressed. This has to be converted into a number giving the change in position in the display file. The Ace display file is laid out in 24 rows of 32 columns, each at addresses 9216 to 9984. An up or down movement changes the memory location by 32 and a left or right movement changes it by 1. I have used these numbers to give the new location of the man.

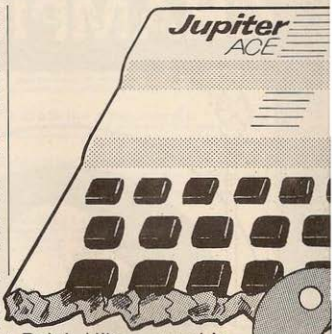
Next the program checks to make sure the man does not bump into a wall and continues only if there is no risk of this.

Then a space is put in the man's last position, and the new position is checked to see whether or not it contains a dot. If it does, the score is incremented. If this score means that all the available dots have been eaten, the screen is refilled.

Now the man is moved to his new position which is stored in the appropriate variable. The ghost-moving section comes next. I found that this was most easily done by having a separate variable for each ghost's position which is put into the variable used by the subroutine as each ghost is moved.

The sequence for each ghost starts by checking whether the ghost should move up or down or neither according to the relative position of the man, and then makes sure that it does not hit a wall. A random generator is used to allow the ghost only limited movement — the game would be impossible if the ghost was always correct, and boring if its movement were fully predictable. When a ghost moves, the space it leaves is replaced with a space or dot as appropriate. This is done by a method which is explained fully in the actual coding. The same procedure is used for left and right movement of the ghost. If the man now occupies the same position as one of the ghosts the game ends.

Obviously all these procedures need additional subroutines to generate the random numbers and refill the screen with dots when required.



Ralph Hilton gets his teeth into Forth games. Have an Ace munch.

The game is loaded in three sections to make full use of the memory but no reloading is necessary to replay.

First, the graphics section is prepared. I have assigned user graphics for the wall and dots as this makes it far easier to type in the screen itself. The graphics are placed into a section of RAM which is calculated as starting at 11264 plus the ASCII code of the character one is defining multiplied by 8. As typing in a list of binary digits is tedious I have converted all the values to decimal.

Here is the listing for the graphics section:

```
: NM 36 126 219 90 126 255 126 36 ;
```

This word puts the values used for the ghost on to the stack. It is a separate word because it is needed several times.

```
: GR 8 * 11263 + DUP
     8 +
     DO
        i C! -1
     +LOOP ;
```

This word takes nine numbers from the stack; the first eight define the character and the ninth is the ASCII value of the character. It makes a loop, using as its limits the sections of memory at the beginning and end of the space we want to fill. It then puts each of the numbers into its appropriate place. It is taken from the Ace manual.

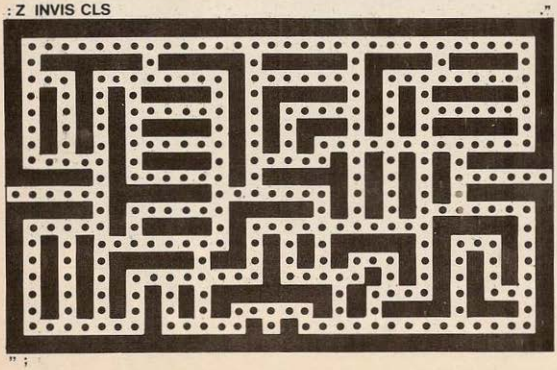
```
: A 85 170 85 170 85 170 85 170 1 GR      Wall
    0  0  0 24 24  0  0  0 2 GR          Dot
   28 20  8 127  8 20 34  65 3 GR         Man
   NM 5 GR
   NM 35 GR ;
```

When you have typed this in, A will run the routine and store the characters appropriately. This section should then be saved on tape by starting the tape player then entering

```
SAVE GRAPHICS
```

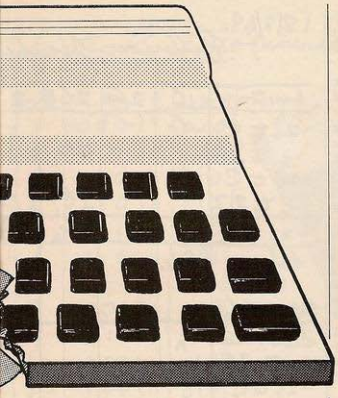
The maze display: snappers and gulpers thrive in this sort of environment.

```
: Z INVIS CLS                                  ."
```



```
" ;
```

FOR GAMES



You can then verify it as explained in the manual and delete it from memory using

FORGET NM

to leave space for the next section, the game itself.

For this section first enter the variables;

0 variable A The score.
0 variable X The man's position.
0 variable W Used for the position of the ghost being moved. Y and Z are moved to W as needed.
0 variable Y The positions of the two
0 variable Z ghosts.

Only two ghosts have been used — a third would fit in the memory but with the speed at which the program runs would make it almost impossible to win.

0 variable SD This holds the random number.
0 variable K This sets the difficulty level.

The subroutines used by the main words need to go in next so that the compiler recognises them when called from the upper words.

```
: B This fills the screen with dots wherever
    there is no wall and is used whenever the
    dots are all eaten.
    9856 9216
    DO Sets a loop to go over the whole
    screen.
    i c@ 1 = 0 = Checks that the space does
    not contain a wall.
    IF
      2 i c! Puts a dot there if it does not.
    THEN
LOOP
5 Y @ c! 5 Z @ c! Puts the ghosts back on
                  the screen.
Y @ Z @ = IF 8 Y @ c! THEN
```

When a ghost leaves a position then 3 is subtracted from the ASCII value of the character so that it is left as it was; dots use 2 and spaces 32 so the ghost is given values 5 and 35, and 3 is added to the ASCII when the ghost is moved there. Here if the two ghosts are in the same place when all the dots are eaten then 2 + 3 + 3 has to go in that space giving a dot when they both leave.

```
K @ DUP 2 > IF 1- THEN K ! Increases the
difficulty level if it is not at maximum;
: RND This is taken from the Ace manual and
        covered there.
        SD @ 75 u* 75 0 D +
        OVER OVER u< - - 1-
        DUP SD!
            u* SWAP DROP ;
: CPS
This is used to add 3 to the position that the
ghost moves into and add 253 when it leaves.
Adding 253 achieves the same as taking away 3
as one is using a single byte.
        SWAP OVER c@ + SWAP c! ;
```

Next the main routines are typed in. M is the routine for moving the man complete with associated checks and score changing. The comments could be typed into the machine but would take up valuable memory and so should be omitted.

```
: M
  INKEY DUP DUP
  52 >SWAP 57 <AND
  This checks that the key is one of the cursor
  control keys 5 to 8; these have ASCII values 53
  through 56.
IF
  52 - DUP Puts the number into the range 1
           to 4
  4 MOD 1 > 31 * 1+ MOD gives the
    remainder after dividing by the preceding
    number so cursor keys 6 and 7 will leave
    32 on the stack while keys 5 and 8 leave 1
    on the stack.
  SWAP 3 < -2 * 1+ * This multiplies the 32
                     or 1 obtained by -1 if
                     keys 5 or 6 were
                     pressed.
  X @ + DUP c@ DUP Leaves on the stack
    the new value of X and two copies of
    what X currently contains.
  1 = 0 =
  IF Continue only if one will not collide with a
    wall.
    32 X @ c! Put a space in the old position
              of the man.
    2 =
    IF Check if the man is eating a dot.
      A @ 1+ DUP DUP A ! 21 0 AT .
      326 MOD 0= IF B THEN Add 1 to the
      score; print the score; check whether all
      the dots have been eaten and refill
      screen if more left.

    THEN
    3 OVER c! X ! Put the man in the new
                  position and store the value
                  of X.
    99 40 BEEP
  ELSE
    DROP DROP Removes unused numbers
              from stack.
    THEN
  ELSE
    DROP
  THEN ;
```

The routines G and H are used together. H is used twice by G to actually move the ghost. H should be typed in before G.

```
: G W @ DUP X @ 16 - <32 * Compares
  the values of X and W to see whether or
  not the ghost should move down. It puts
  32 on the stack if it should.
  SWAP X @ 16 + > - 32 * + H puts - 32
      on the stack if the ghost should move
      up, and then uses H to move it appro-
      priately.
  W @ 32 MOD X @32 MOD > - 2 * 1+ H
  Puts 1 or -1 on the stack after comparing
  the horizontal positions of X and W to
  move ghost left or right.
: H W @ + DUP c@ Finds the new position
                 of the ghost.
  1 = 0 = Makes sure that it is not in a wall.
  K @ RND 0= AND Uses the difficulty
                 variable K and RND to
                 limit the probability of
                 the ghost's movement.
  IF
    253 W @ CPS Puts a space or dot where
                the ghost was.
    3 OVER CPS Puts the ghost on the
               screen.
    W ! Stores the new position of the ghost
  ELSE
    DROP
  THEN ;
```

The routines are now linked together by the program word which is Run.

```
: RUN FAST
  9249 X ! 9339 Y ! 9479 Z ! Sets initial
                positions of man and ghosts.
  0 A ! Zeros score. 6 K ! Sets initial difficulty.
  B                Fills the screen with dots.
  3 9249 c!        Puts the man on the screen. B
  ;B               puts on the ghosts.
  BEGIN            The main control loop.
    M                    Move man.
    Z @ W ! G W @ Z !    Moves the ghost Z by
      putting its value into W which is used by H.
    Y @ W ! G W @ Y !    Does the same for Y.
    X @ DUP Y @ = SWAP Z @ = OR
  UNTIL Compares X to Z and Y. If either
        equal X then the procedure ends
        otherwise it goes back to Begin.
  SLOW
  999 999 BEEP ;
```

The game is stored entering

,SAVE RUN

The screen is created and, then saved as a series of bytes. Enter

: Z INVIS CLS."

leaving enough space between the CLS and ." so that there is only one space left at the end of the line. Use Shift 9 to put the Ace in graphics mode then, using A for the wall and B for the dots, type in the 20 lines of screen per the attached diagram. On the next line type " ;

Entering Z will now give you the screen in the correct position and it can be saved on to tape by entering

8192 768 BSAVE screen

Start the tape and press enter.

Clear the memory with

FORGET Z

The program is now loaded with

```
LOAD GRAPHICS
A
FORGET NM
```

Enter these three together and then start the tape. Stop the tape when you see the cursor.

INVIS LOAD RUN 0 0 BLOAD SCREEN

Enter this and then restart the tape. Stop it when the screen is full. You can now play the game by entering Run.

If you have queries about the program I can answer them. Write to me with stamped, addressed envelope at 23 Grimston Avenue, Folkestone, Kent. ■

INCREDIBLE

IF YOU ARE buying an Oric 1 computer, you are acquiring a piece of microelectronic equipment that is the state of the art in home computers. Inside the Oric case is a 6502A central processor unit, CPU; two 2764 read-only memory — ROM — chips;a 6522 versatile interface adaptor, VIA; and eight 4164 dynamic random access memory — RAM — chips as well as a number of other integrated circuits.

All these circuits are mounted on a printed-circuit board and there are inputs and outputs to connect the computer to the outside world. That hardware specification produces a computer that will calculate using one or more high-level languages, control a printer or some other peripheral piece of equipment, interface with a Modem for communicating via British Telecom telephone lines or store and retrieve information from a mass-storage unit called a floppy disc. The Oric computer must contain nearly one million transistors and uses perhaps five watts of power.

You may be forgiven for having a blasé attitude towards "the chip". Although home computers continue to develop at breakneck pace, a number of small machines with a built-in Basic interpreter have been available for three or four years in this country.

But compare, for a moment, the Oric with the Mark 1 computer built at Manchester University in 1948. Like the Oric the Mark 1 used dynamic memory. Flip-flops, the electronic circuit at the heart of static memory devices, had to be constructed out of EF-50 pentode valves and the quantities that would have been necessary were simply not a practical proposition.

So Professor Williams, the head of the development team, invented a way of storing binary numbers using a 12in. diameter cathode ray tude, CRT, roughly similar to the tube in a portable television. He found that it was possible to detect the presence or absence of a pulse by the charge generated in a plate held against the front of the CRT — where the picture would normally be displayed. The charge decayed in about 0.2 seconds but if it was refreshed within that time, it was possible to store 2,048 bits for a period of several hours.

The memory for a stored-program electronic computer was the most troublesome problem at that time. Other groups worked on the development of memory storage using mercury delay lines in which a vibration, or sound wave, was put into one end of a trough of mercury and recovered some time later at the other end.

This technique was also dynamic because the impulse had to be recirculated constantly if the information was not to be lost. One advantage of the Williams tube over the mercury delay line was that it allowed random access, while the mercury store was a serial device where one bit chased another down the trough.

The Mark 1 computer had a 32-bit word length compared to the eight-bit bytes that are now standard in the Oric and other home computers. The main store of the machine consisted of a single Williams tube storing 32 words, and — as far as one can make any comparison — that is matched by the 48,000 bytes available in the full Oric.

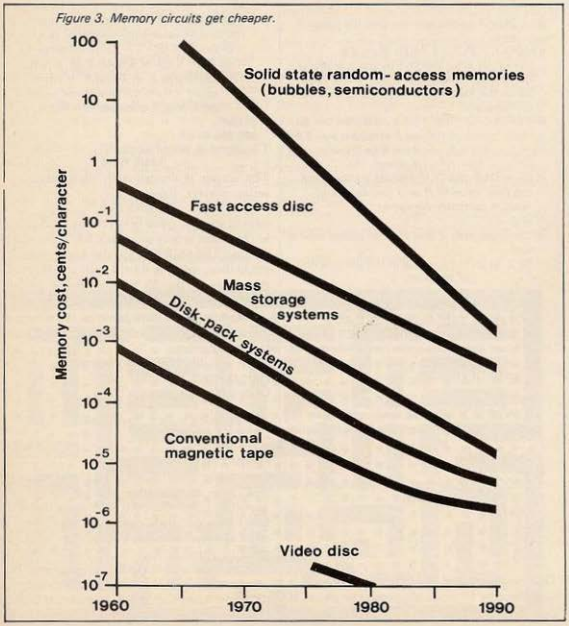


Figure 3. Memory circuits get cheaper.

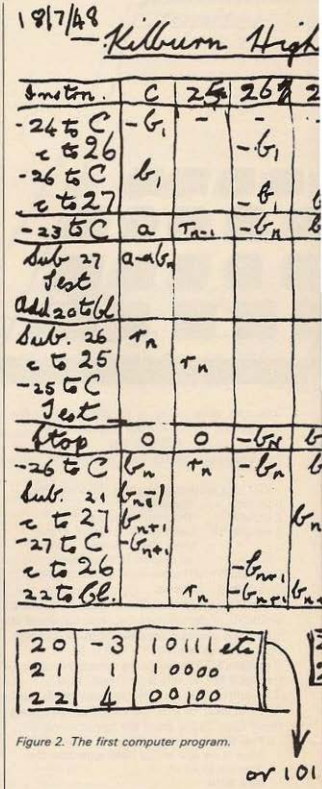
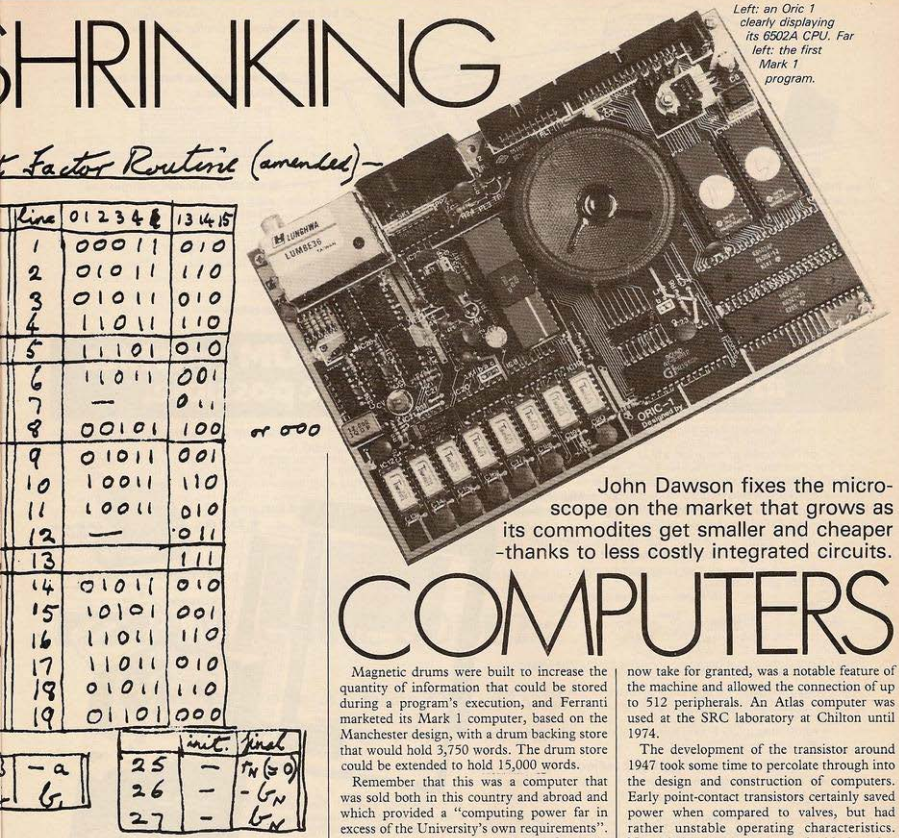


Figure 2. The first computer program.

SHRINKING COMPUTERS



Left: an Oric 1 clearly displaying its 6502A CPU. Far left: the first Mark 1 program.

John Dawson fixes the microscope on the market that grows as its commodites get smaller and cheaper -thanks to less costly integrated circuits.

The arithmetic logic unit, ALU, simply a part of the CPU in the Oric, consisted of a subtractor built from valves and an accumulator and was made — once again to save cost — out of a Williams tube. The Mark 1 took 1.2ms. to carry out each instruction — about 800 instructions per second.

Figure 1 is taken from *History of Manchester Computers,* National Computing Centre, and shows the instruction set for the Manchester Mark 1 — the world's first stored-program electronic computer. Figure 2, from the same publication, shows a revised version of the first computer program, the first program actually ran in June 1948.

Some 18 months later an enlarged version of the Mark 1 was doing useful work for the University and IBM was negotiating for the use of the Williams tube under licence in its 701 series computer.

Magnetic drums were built to increase the quantity of information that could be stored during a program's execution, and Ferranti marketed its Mark 1 computer, based on the Manchester design, with a drum backing store that would hold 3,750 words. The drum store could be extended to hold 15,000 words.

Remember that this was a computer that was sold both in this country and abroad and which provided a "computing power far in excess of the University's own requirements". Hardware was an accurate term for these machines. The weight of the valves and other components meant that rigid metal frames were required to support the circuit boards.

As one small part of the whole machine, a computer of the late sixties using a ferrite core store with a capacity of 4,000 bits would have a frame about the size of a single-bed mattress with driver amplifiers and read circuits to store and recover the state of each core in the small block in the centre of the chassis. Contrast also the 25 kilowatts consumed by the early Manchester computers with the power requirements of the Oric.

Later, in 1959, Manchester started the design and construction of Atlas, which was to be the world's largest computer. The Manchester Atlas was formally brought into service in December 1962. The machine had a 48-bit word, 16K of main store and 8K of read-only store. Interrupt handling, which you now take for granted, was a notable feature of the machine and allowed the connection of up to 512 peripherals. An Atlas computer was used at the SRC laboratory at Chilton until 1974.

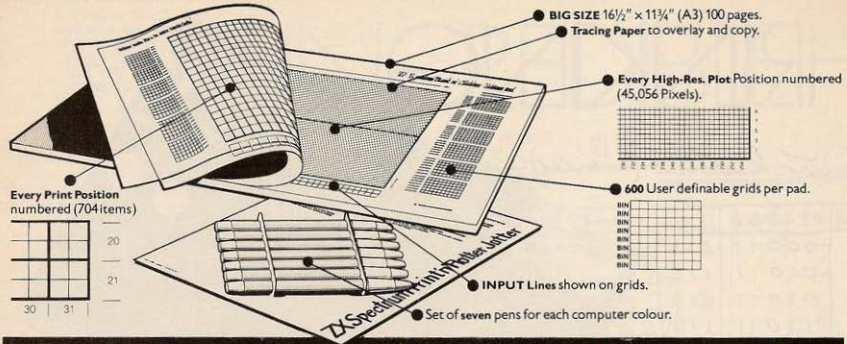
The development of the transistor around 1947 took some time to percolate through into the design and construction of computers. Early point-contact transistors certainly saved power when compared to valves, but had rather unstable operating characteristics. Nevertheless computers were the ideal market for transistors and for the solid-state integrated circuits that followed.

The reason for the success of the transistor in computer circuits is that digital designs require large numbers of active devices in comparison to the analogue designs used for communications equipment and the entertainment market. A six-transistor radio was an advanced piece of equipment in the early sixties and if it had a radio-frequency amplifier employing another transistor, it was definitely upmarket and advertised as such.

On the other had, a central processor unit such as the 8085, marketed by Intel uses about 6,200 transistors and that takes no account of the memory for the computer or the other control circuits.

It would be comforting to think that the development of microelectronics for the

(continued on page 73)



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(continued from page 71)

computer market came about because of the opportunities for enhancing the lives of individuals or even for commercial reasons. Not so — microelectronics was spawned by missile and satellite programs and promoted by military and space agencies in the United States.

Integrated circuits became possible only after someone conceived that transistors, resistors, diodes, and so on, could be separated by insulation on the same piece of silicon rather than the physical separation which previously had been the rule. In 1964, Gordon Moore, the director of research at Fairchild, predicted that integrated circuits would continue to double in complexity every year. In 1977 some circuits that were commercially available contained more than 260,000 elements and Moore's law has continued to hold true.

The cost of integrated circuits has declined consistently. Figure 3 illustrates the downward trend for memory circuits. Changes in technology have helped to keep the trend running according to Moore's prediction. X-ray lithography is a form of contact lithography which allows the production of integrated circuits with finer "wires" — strips of metal that connect one circuit element to another — than was possible with ultraviolet or visible light lithography. Gallium arsenide offers much higher switching speeds than silicon and the Josephson Junction, operating at temperatures close to absolute zero, may be the fundamental component of the future.

We may have swapped the expensive, heavy, power-consuming, air conditioning of the past for a similar refrigeration plant in the future to allow a few cubic inches of silicon to run at BIPS speeds. BIPS? — billions of instructions per second, of course. A few cubic inches? Well, the speed of light starts to slow a computer down when different parts of the machine are some distance apart. Josephson Junction machines will operate most efficiently if the computer can be kept within a total dimension of a few inches in any direction so that electrical impulses do not have to travel even a few metres from one part of the micro to another.

How does all of this reflect on the little Oric — the state-of-the-art machine? The Oric uses essentially the same architecture as the first Manchester machine. John von Neumann set out the principle of a computer in which the instructions are combined with the data, the Harvard architecture separated the two.

The beginners' all-purpose symbolic instruction code — Basic — high-level language supplied with the Oric is beyond the dreams of the first pioneers in the North of England. After all, it was those connected with the earliest computers who thought, as they gazed at the machine in almost religious awe, that four computers would be sufficient for the world's computing needs. ■

Decimal value of function bits	An early notation	Modern mnemonic	Explanation of operation
0	s, C	JMP S	Absolute indirect unconditional jump: set the control register equal to the contents of address S.
1	c+s, C	JRP S	Relative indirect unconditional jump: add the contents of address S to the control register.
2	-s, A	LDN S	Load negative: set the accumulator equal to the negated contents of address S.
3	a, S	STO S	Store: copy the contents of the accumulator to address S.
4 or 5	a-s, A	SUB S	Subtract: set the new value of the accumulator equal to the former contents minus the contents of address S.
6	Test	CMP	Compare against zero: the value in the accumulator is tested. If it is less than zero, one is added to the control register thus causing the next sequential instruction to be skipped.
7	Stop	STP	Stop: cease automatic mode, and await manual commands from the operator's keyboard.

Figure 1. The Manchester Mark 1 instruction set.

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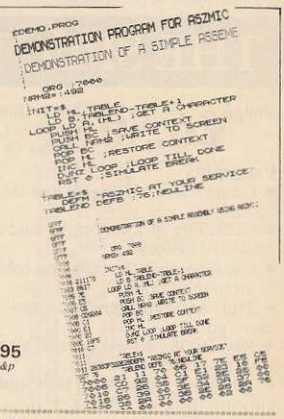

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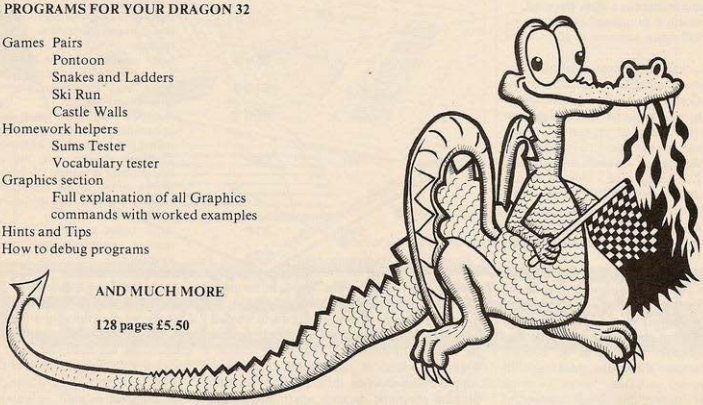

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ZX-81 EDITOR

Trevor Hill sets out a more comprehensive and user-friendly machine-code monitor for the Sinclair ZX-81.

MANY machine-code routines suffer, in my opinion, from some deficiency, typically not disassembling all Z-80 instructions; not dealing correctly with RST 08 and RST 28 instructions; not easily allowing the loading of other programs while the routines are in memory; not providing facilities for expansion; not being particularly user-friendly.

These routines have been written in an attempt to overcome these difficulties. The first three routines and operating system occupy just under 2K of memory and present a formidable task to input and get working in one go. I would therefore suggest that the program is broken down into several stages.

The machine-code utility program is intended to provide routines that are particularly user-friendly. The routines are tucked away in memory so that their presence is not noticed until they are actually required.

Figure 1 details the Basic program which is loaded into the computer in the normal manner. Once loaded the program runs automatically placing the machine-code routines — initially held in a string in the variables area — at the top end of RAM. A reduced value for RAMtop is then automatically set and the program commits hari-kari by executing New. This brings into operation the revised value of RAMtop so protecting the machine code, and wipes out the loading program, giving what appears to be a completely empty RAM.

Any other program on which you may want to use the routines can then be loaded in the normal way. To access the routines the following lines of Basic are added to the program:

```
9996 STOP
9997 POKE 16417, 0
9998 RAND USER 32598
9999 GOTO 9996
```

The menu is displayed by Run 9999. You will see from figure 2 that the menu has been designed to accommodate up to 16 routines. The program now waits for you to select a particular routine by input of the appropriate hexadecimal digit. The digit is displayed and once checked the routine may be executed by Newline.

This first routine is a disassembler routine which deals correctly with all the Z-80 instructions as used on the ZX-81. In particular it recognises that the instruction RST 08 is required to be followed by one data byte and that RST 28 may be followed by any number of data bytes terminated by 34. When executed you are asked for the start address, finish address and dump details, one to printer — any other hexadecimal digit to screen.

Figure 3 illustrates the format used whenever input is required: a prompt message followed by a question mark.

The routines have been designed to protect the user as far as possible. For example if the routine is requesting an address it will only accept hex digits and these have to be of exactly the right length.

Once you have input the data, the question mark will remain until you confirm it is correct by typing Newline. Should you make a typing error this may be corrected, as in Basic, by using the Rubout key — Shift 0.

In this, and any of the other routines, whenever input is being requested the routine may be terminated by using the Break key.

The bottom section, figure 5, is a typical output from the disassembler. The first column gives the start address of the instructions, the second the instruction code and third the mnemonic.

Since this is a one-pass disassembler, labels are not included, therefore all jump-relative instructions give, as part of the mnemonic, the absolute jump address.

If the output is to the screen then Screen Fill will generate the usual message — report code 5. Display may be continued, as in Basic, by use of Cont.

The features detailed for the previous routine apply to the Print Data routine. The output is now data rather than instructions.

This Write routine enables code or data to be Input. The start address is requested and then code or data may be input. It is intended that each line of input should correspond to one instruction so the maximum number of bytes that will be accepted is 4. The program knows that each byte occupies two hex digits, so it will not allow an odd number of digits to be input.

Figure 4 lists a suitable Hex loader. Run 100 to list code, Run 300 to write code, and Run 500 to execute code.

As it stands the code in the line 1 Rem statement — figure 5 — will wipe out the Loader program so the following modification is necessary during development.

Change byte 40A7 to C9. This is the Ret instruction code and will stop the routine executing New. Now while you are developing the program you will have to manually set the reduced value for RAMtop each time the computer is switched on and before loading the partially completed program. This can be done by direct commands:

```
POKE 16389, 116
NEW.
```

The menu operating system, first three routines and data occupy just under 2K of memory and the string variable has been set to make the top 3K of RAM available. Therefore 1K is spare for further routines, but the program may be easily modified to make more memory available if necessary.

The machine-code listings have been taken directly from the program using the disassembler and therefore should contain no errors but be careful not to confuse 8,B 6,5 and so on.

If you do not relish writing such a large machine-code program then I can supply a tape and full loading instructions for £3. They may be obtained from Trevor Hill, 1 Highcroft Close, Yardley Gobion, Northants.

(for listings, see page 77)

Figure 1.

```
  1 REM  40 CHARACTERS TO BE
         REPLACED BY M/C
 10 DIM M$(3040)
 20 RAND USR 16514
 30 SAVE "ROUTINES"
 40 RAND USR 16531
```

Figure 2.

```
          MENU
          ====
     0 PRINT CODE
     1 PRINT DATA
     2 WRITE
     3 INSERT
     4 DELETE
     5 TRANSFER
     6 SEARCH
     7 REPLACE
     8 RUN CODE
     9
     A
     B
     C
     D
     E
     F
ROUTINE  ?
```

Figure 3.

```
          0 PRINT CODE
START ADDRESS        4002
FINISH ADDRESS       4009
1 FOR PRINTER          ?
```

Figure 4.

```
 99 STOP
100 PRINT "LIST FROM"
110 GOSUB 8100
120 LET B=X
130 GOSUB 8000
140 PRINT X$;" ";
150 FOR V=1 TO 4
160 LET X=PEEK B
170 GOSUB 8050
180 PRINT X$;" ";
190 LET B=B+1
200 NEXT V
210 PRINT
220 GOTO 130
300 PRINT "WRITE TO"
310 GOSUB 8100
320 LET A=X
330 SCROLL
340 LET X=A
350 GOSUB 8000
360 PRINT X$;"  ";
370 INPUT A$. THEN STOP
380 IF LEN A$<>2*INT (LEN A$/2)
THEN GOTO 370
400 PRINT A$
410 LET X$=A$( TO 2)
420 GOSUB 8120
430 POKE A,X
440 LET A=A+1
450 LET A$=A$(3 TO )
460 IF A$="" THEN GOTO 410
470 GOTO 330
500 PRINT "RUN FROM"
510 GOSUB 8100
520 CLS
530 RAND USR X
540 STOP
3000 LET X=INT (A/256)
3010 LET Y=X
3020 GOSUB 8050
3030 LET X=A-Y*256
3040 GOTO 8060
3050 LET X$=""
3060 LET K=INT (X/16)
3070 LET X$=X$+CHR$ (K+28)
3080 LET X$=X$+CHR$ (X-K*16+28)
3090 RETURN
3100 INPUT X$
3110 IF LEN X$<>4 THEN GOTO 8100
3120 LET X=0
3130 FOR I=1 TO LEN X$
3140 LET X=X*16+CODE X$(I)-28
3150 NEXT I
3160 RETURN
```

Figure 5.

```
4002 2A1040   LD   HL,(4010)
4005 110600   LD   DE,0006
4008 19       ADD  HL,DE
4009 EB       EX   DE,HL
400A 210074   LD   HL,7400
400D 01E008   LD   BC,08E0
4010 EDB0     LDIR
4012 C9       RET
4013 2A1040   LD   HL,(4010)
4016 110600   LD   DE,0006
4019 19       ADD  HL,DE
401A 110074   LD   DE,7400
401D 01E008   LD   BC,08E0
4020 EDB0     LDIR
4022 3E74     LD   A,74
4024 320540   LD   (4005),A
40A7 CDC303   CALL 03C3
```

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BASICARE MICRO SYSTEM

(continued from page 75)

Machine-code listing.

```
7C00  A7A8A9AA  DEFB
7C04  ADB1C0A5  DEFB
7C08  A6C1A610  DEFB
7C0C  43391045  DEFB
7C10  91E7E7C3  DEFB
7C14  C5C1C262  DEFB
7C18  A845A847  DEFB
7C1C  D649D647  DEFB
7C20  A649A629  DEFB
7C24  26A62835  DEFB
7C28  B13828AB  DEFB
7C2C  2828AB9C  DEFB
7C30  9D9E9FA0  DEFB
7C34  A1A2A335  DEFB
7C38  3A38AD56  DEFB
7C3C  31B1372A  DEFB
7C40  B94B8D2F  DEFB
7C44  B5CD58A9  DEFB
7C48  58A8333A  DEFB
7C4C  B733C326  DEFB
7C50  33A93D34  DEFB
7C54  B734B728  DEFB
7C58  853534B5  DEFB
7C5C  3738B92F  DEFB
7C60  B580D3E2  DEFB
7C64  CBCB29AE  DEFB
7C68  2AAEE5E8  DEFB
7C6C  661AA64F  DEFB
7C70  E6105C11  DEFB
7C74  DA45DA80  DEFB
7C78  80104191  DEFB
7C7C  5CDAA9CF  DEFB
7C80  80CB0080  DEFB
7C84  808033BF  DEFB
7C88  BF33A8A8  DEFB
7C8C  35B435AA  DEFB
7C90  B5B247A8  DEFB
7C94  49A8C7C9  DEFB
7C98  3831A638  DEFB
7C9C  37A6E438  DEFB
7CA0  C7272EB9  DEFB
7CA4  372A8838  DEFB
7CA8  2AB91028  DEFB
7CAC  91332AAC  DEFB
7CB0  83AE38C3  DEFB
7CB4  83A82EB2  DEFB
7CB8  9CA49D9E  DEFB
7CBC  CDCDCDCD  DEFB
7CC0  49A947A9  DEFB
7CC4  2E9A379A  DEFB
7CC8  CFCF8080  DEFB
7CCC  5E1ADEE9  DEFB
7CD0  E9E0E0E0  DEFB
7CD4  E0A6A6AE  DEFB
7CD8  B78080AE  DEFB
7CDC  A92EB729  DEFB
7CE0  87CD23B5  DEFB
7CE4  E2D334B9  DEFB
7CE8  3334B5C8  DEFB
7CEC  292F33BF  DEFB
7CF0  D1D1D1D1  DEFB
7CF4  D12D2831  DEFB
7CF8  B9452BA7  DEFB
7CFC  101DA927  DEFB
7D00  9FA6C9B3  DEFB
7D04  AEB89DB6  DEFB
7D08  C62DB12E  DEFB
7D0C  BD2EBE10  DEFB
7D10  41911041  DEFB
7D14  152A2791  DEFB
7D18  CDD3D9DF  DEFB
7D1C  3CE5EBEE  DEFB
7D20  F3F3F3F5  DEFB
7D24  9181895D  DEFB
7D28  6AF9753A  DEFB
7D2C  709CA176  DEFB
7D30  A4AAADFC  DEFB
7D34  B396B6B6  DEFB
7D38  C1C7B71B  DEFB
7D3C  81A1E47F  DEFB
7D40  0F095C27  DEFB
7D44  A629AA37  DEFB
7D48  B137B72A  DEFB
7D4C  8D31A926  DEFB
7D50  9A2FB734  DEFB
```

```
7D54  3AB928A5  DEFB
7D58  26A91AC1  DEFB
7D5C  38B926AB  DEFB
7D60  1AE922E3  DEFB
7D64  E9EFF4FA  DEFB
7D68  8FC7FA17  DEFB
7D6C  00E01713  DEFB
7D70  7A45008A  DEFB
7D74  C500F559  DEFB
```

(continued on next page)

```
7833 CDFC76   CALL 7AFC
7836 C9       RET
7837 CD7C76   CALL 767C
7839 1E00     LD E,0
783B CD5278   CALL 7852
783E 2A2110   LD HL,(2121)
7841 ED5B     DEFB 91
7843 3C00     LD E,0
7845 22210    LD (2121),A
7848 19       ADD HL,DE
7849 3678     LD (HL),78
784B 2C       INC L
784C 7E       LD A,(HL)
784D 2B       DEC HL
784E 2B       DEC HL
784F 2B       DEC HL
7850 C9       RET
7851 CD7C76   CALL 767C
7854 CDA678   CALL 78A6
7857 2B       DEC HL
7858 FECD     CP CD
785A 20F8     JR NZ,7854
785C 2B       DEC HL
785D FECD     CP CD
785F 20F8     JR NZ,7859
7861 2B       DEC HL
7862 FECD     CP CD
7864 20F8     JR NZ,7860
7866 2B       DEC HL
7867 FECD     CP CD
7869 20F8     JR NZ,7865
786B 2B       DEC HL
786C 2B       DEC HL
786D 2B       DEC HL
786E 2B       DEC HL
786F 2B       DEC HL
7870 C9       RET
7871 CD7C76   CALL 767C
7874 2B       DEC HL
7875 FECD     CP CD
7877 20F8     JR NZ,7871
7879 2B       DEC HL
787A FECD     CP CD
787C 20F8     JR NZ,7876
787E 2B       DEC HL
787F FECD     CP CD
7881 20F8     JR NZ,787B
7883 2B       DEC HL
7884 FECD     CP CD
7886 20F8     JR NZ,7880
7888 2B       DEC HL
7889 FECD     CP CD
788B 20F8     JR NZ,7885
788D 2B       DEC HL
788E 2B       DEC HL
788F 2B       DEC HL
7890 2B       DEC HL
7891 2B       DEC HL
7892 C9       RET
7893 CD7C76   CALL 767C
7896 2B       DEC HL
7897 FECD     CP CD
7899 20F8     JR NZ,7893
789B 2B       DEC HL
789C FECD     CP CD
789E 20F8     JR NZ,7898
78A0 2B       DEC HL
78A1 FECD     CP CD
78A3 20F8     JR NZ,789D
78A5 2B       DEC HL
78A6 FECD     CP CD
78A8 20F8     JR NZ,78A2
78AA 2B       DEC HL
78AB FECD     CP CD
78AD 20F8     JR NZ,78A7
78AF 2B       DEC HL
78B0 FECD     CP CD
78B2 20F8     JR NZ,78AC
78B4 2B       DEC HL
78B5 FECD     CP CD
78B7 20F8     JR NZ,78B1
78B9 2B       DEC HL
78BA FECD     CP CD
78BC 20F8     JR NZ,78B6
78BE 2B       DEC HL
78BF FECD     CP CD
78C1 20F8     JR NZ,78BB
78C3 2B       DEC HL
78C4 FECD     CP CD
78C6 20F8     JR NZ,78C0
78C8 2B       DEC HL
78C9 FECD     CP CD
78CB 20F8     JR NZ,78C5
78CD 2B       DEC HL
78CE FECD     CP CD
78D0 20F8     JR NZ,78CA
78D2 2B       DEC HL
78D3 FECD     CP CD
78D5 20F8     JR NZ,78CF
78D7 2B       DEC HL
78D8 FECD     CP CD
78DA 20F8     JR NZ,78D4
78DC 2B       DEC HL
78DD FECD     CP CD
78DF 20F8     JR NZ,78D9
78E1 2B       DEC HL
78E2 FECD     CP CD
78E4 20F8     JR NZ,78DE
78E6 2B       DEC HL
78E7 FECD     CP CD
78E9 20F8     JR NZ,78E3
78EB 2B       DEC HL
78EC FECD     CP CD
78EE 20F8     JR NZ,78E8
78F0 2B       DEC HL
78F1 FECD     CP CD
78F3 20F8     JR NZ,78ED
78F5 2B       DEC HL
78F6 FECD     CP CD
78F8 20F8     JR NZ,78F2
78FA 2B       DEC HL
78FB FECD     CP CD
78FD 20F8     JR NZ,78F7
78FF 2B       DEC HL
7900 FECD     CP CD
7902 20F8     JR NZ,78FC
7904 2B       DEC HL
7905 FECD     CP CD
7907 20F8     JR NZ,7901
7909 2B       DEC HL
790A FECD     CP CD
790C 20F8     JR NZ,7906
790E 2B       DEC HL
790F FECD     CP CD
7911 20F8     JR NZ,790B
7913 2B       DEC HL
7914 FECD     CP CD
7916 20F8     JR NZ,7910
7918 2B       DEC HL
7919 FECD     CP CD
791B 20F8     JR NZ,7915
791D 2B       DEC HL
791E FECD     CP CD
7920 20F8     JR NZ,791A
7922 2B       DEC HL
7923 FECD     CP CD
7925 20F8     JR NZ,7920
7927 2B       DEC HL
7928 FECD     CP CD
792A 20F8     JR NZ,7924
792C 2B       DEC HL
792D FECD     CP CD
792F 20F8     JR NZ,792A
7931 2B       DEC HL
7932 FECD     CP CD
7934 20F8     JR NZ,792F
7936 2B       DEC HL
7937 FECD     CP CD
7939 20F8     JR NZ,7934
793B 2B       DEC HL
793C FECD     CP CD
793E 20F8     JR NZ,7939
7940 2B       DEC HL
7941 FECD     CP CD
7943 20F8     JR NZ,793E
7945 2B       DEC HL
7946 FECD     CP CD
7948 20F8     JR NZ,7943
794A 2B       DEC HL
794B FECD     CP CD
794D 20F8     JR NZ,7948
794F 2B       DEC HL
7950 FECD     CP CD
7952 20F8     JR NZ,794D
7954 2B       DEC HL
7955 FECD     CP CD
7957 20F8     JR NZ,7952
7959 2B       DEC HL
795A FECD     CP CD
795C 20F8     JR NZ,7957
795E 2B       DEC HL
795F FECD     CP CD
7961 20F8     JR NZ,795C
7963 2B       DEC HL
7964 FECD     CP CD
7966 20F8     JR NZ,7961
7968 2B       DEC HL
7969 FECD     CP CD
796B 20F8     JR NZ,7966
796D 2B       DEC HL
796E FECD     CP CD
7970 20F8     JR NZ,796B
7972 2B       DEC HL
7973 FECD     CP CD
7975 20F8     JR NZ,7970
7977 2B       DEC HL
7978 FECD     CP CD
797A 20F8     JR NZ,7975
797C 2B       DEC HL
797D FECD     CP CD
797F 20F8     JR NZ,797A
7981 2B       DEC HL
7982 FECD     CP CD
7984 20F8     JR NZ,7979
7986 2B       DEC HL
7987 FECD     CP CD
7989 20F8     JR NZ,7984
798B 2B       DEC HL
798C FECD     CP CD
798E 20F8     JR NZ,7989
7990 2B       DEC HL
7991 FECD     CP CD
7993 20F8     JR NZ,798E
7995 2B       DEC HL
7996 FECD     CP CD
7998 20F8     JR NZ,7993
799A 2B       DEC HL
799B FECD     CP CD
799D 20F8     JR NZ,7998
799F 2B       DEC HL
79A0 FECD     CP CD
79A2 20F8     JR NZ,799D
79A4 2B       DEC HL
79A5 FECD     CP CD
79A7 20F8     JR NZ,79A2
79A9 2B       DEC HL
79AA FECD     CP CD
79AC 20F8     JR NZ,79A7
79AE 2B       DEC HL
79AF FECD     CP CD
79B1 20F8     JR NZ,79AC
79B3 2B       DEC HL
79B4 FECD     CP CD
79B6 20F8     JR NZ,79B1
79B8 2B       DEC HL
79B9 FECD     CP CD
79BB 20F8     JR NZ,79B6
79BD 2B       DEC HL
79BE FECD     CP CD
79C0 20F8     JR NZ,79BB
79C2 2B       DEC HL
79C3 FECD     CP CD
79C5 20F8     JR NZ,79C0
79C7 2B       DEC HL
79C8 FECD     CP CD
79CA 20F8     JR NZ,79C5
79CC 2B       DEC HL
79CD FECD     CP CD
79CF 20F8     JR NZ,79CA
79D1 2B       DEC HL
79D2 FECD     CP CD
79D4 20F8     JR NZ,79CF
79D6 2B       DEC HL
79D7 FECD     CP CD
79D9 20F8     JR NZ,79D4
79DB 2B       DEC HL
79DC FECD     CP CD
79DE 20F8     JR NZ,79D9
79E0 2B       DEC HL
79E1 FECD     CP CD
79E3 20F8     JR NZ,79DE
79E5 2B       DEC HL
79E6 FECD     CP CD
79E8 20F8     JR NZ,79E3
79EA 2B       DEC HL
79EB FECD     CP CD
79ED 20F8     JR NZ,79E8
79EF 2B       DEC HL
79F0 FECD     CP CD
79F2 20F8     JR NZ,79ED
79F4 2B       DEC HL
79F5 FECD     CP CD
79F7 20F8     JR NZ,79F2
79F9 2B       DEC HL
79FA FECD     CP CD
79FC 20F8     JR NZ,79F7
79FE 2B       DEC HL
79FF FECD     CP CD
7A01 20F8     JR NZ,79FC
7A03 2B       DEC HL
7A04 FECD     CP CD
7A06 20F8     JR NZ,7A01
7A08 2B       DEC HL
7A09 FECD     CP CD
7A0B 20F8     JR NZ,7A06
7A0D 2B       DEC HL
7A0E FECD     CP CD
7A10 20F8     JR NZ,7A0B
7A12 2B       DEC HL
7A13 FECD     CP CD
7A15 20F8     JR NZ,7A10
7A17 2B       DEC HL
7A18 FECD     CP CD
7A1A 20F8     JR NZ,7A15
7A1C 2B       DEC HL
7A1D FECD     CP CD
7A1F 20F8     JR NZ,7A1A
7A21 2B       DEC HL
7A22 FECD     CP CD
7A24 20F8     JR NZ,7A1F
7A26 2B       DEC HL
7A27 FECD     CP CD
7A29 20F8     JR NZ,7A24
7A2B 2B       DEC HL
7A2C FECD     CP CD
7A2E 20F8     JR NZ,7A29
7A30 2B       DEC HL
7A31 FECD     CP CD
7A33 20F8     JR NZ,7A2E
7A35 2B       DEC HL
7A36 FECD     CP CD
7A38 20F8     JR NZ,7A33
7A3A 2B       DEC HL
7A3B FECD     CP CD
7A3D 20F8     JR NZ,7A38
7A3F 2B       DEC HL
7A40 FECD     CP CD
7A42 20F8     JR NZ,7A3D
7A44 2B       DEC HL
7A45 FECD     CP CD
7A47 20F8     JR NZ,7A42
7A49 2B       DEC HL
7A4A FECD     CP CD
7A4C 20F8     JR NZ,7A47
7A4E 2B       DEC HL
7A4F FECD     CP CD
7A51 20F8     JR NZ,7A4C
7A53 2B       DEC HL
7A54 FECD     CP CD
7A56 20F8     JR NZ,7A51
7A58 2B       DEC HL
7A59 FECD     CP CD
7A5B 20F8     JR NZ,7A56
7A5D 2B       DEC HL
7A5E FECD     CP CD
7A60 20F8     JR NZ,7A5B
7A62 2B       DEC HL
7A63 FECD     CP CD
7A65 20F8     JR NZ,7A60
7A67 2B       DEC HL
7A68 FECD     CP CD
7A6A 20F8     JR NZ,7A65
7A6C 2B       DEC HL
7A6D FECD     CP CD
7A6F 20F8     JR NZ,7A6A
7A71 2B       DEC HL
7A72 FECD     CP CD
7A74 20F8     JR NZ,7A6F
7A76 2B       DEC HL
7A77 FECD     CP CD
7A79 20F8     JR NZ,7A74
7A7B 2B       DEC HL
7A7C FECD     CP CD
7A7E 20F8     JR NZ,7A79
7A80 2B       DEC HL
7A81 FECD     CP CD
7A83 20F8     JR NZ,7A7E
7A85 2B       DEC HL
7A86 FECD     CP CD
7A88 20F8     JR NZ,7A83
7A8A 2B       DEC HL
7A8B FECD     CP CD
7A8D 20F8     JR NZ,7A88
7A8F 2B       DEC HL
7A90 FECD     CP CD
7A92 20F8     JR NZ,7A8D
7A94 2B       DEC HL
7A95 FECD     CP CD
7A97 20F8     JR NZ,7A92
7A99 2B       DEC HL
7A9A FECD     CP CD
7A9C 20F8     JR NZ,7A97
7A9E 2B       DEC HL
7A9F FECD     CP CD
7AA1 20F8     JR NZ,7A9C
7AA3 2B       DEC HL
7AA4 FECD     CP CD
7AA6 20F8     JR NZ,7AA1
7AA8 2B       DEC HL
7AA9 FECD     CP CD
7AAB 20F8     JR NZ,7AA6
7AAD 2B       DEC HL
7AAE FECD     CP CD
7AB0 20F8     JR NZ,7AAB
7AB2 2B       DEC HL
7AB3 FECD     CP CD
7AB5 20F8     JR NZ,7AB0
7AB7 2B       DEC HL
7AB8 FECD     CP CD
7ABA 20F8     JR NZ,7AB5
7ABC 2B       DEC HL
7ABD FECD     CP CD
7ABF 20F8     JR NZ,7ABA
7AC1 2B       DEC HL
7AC2 FECD     CP CD
7AC4 20F8     JR NZ,7ABF
7AC6 2B       DEC HL
7AC7 FECD     CP CD
7AC9 20F8     JR NZ,7AC4
7ACB 2B       DEC HL
7ACC FECD     CP CD
7ACE 20F8     JR NZ,7AC9
7AD0 2B       DEC HL
7AD1 FECD     CP CD
7AD3 20F8     JR NZ,7ACE
7AD5 2B       DEC HL
7AD6 FECD     CP CD
7AD8 20F8     JR NZ,7AD3
7ADA 2B       DEC HL
7ADB FECD     CP CD
7ADD 20F8     JR NZ,7AD8
7ADF 2B       DEC HL
7AE0 FECD     CP CD
7AE2 20F8     JR NZ,7ADD
7AE4 2B       DEC HL
7AE5 FECD     CP CD
7AE7 20F8     JR NZ,7AE2
7AE9 2B       DEC HL
7AEA FECD     CP CD
7AEC 20F8     JR NZ,7AE7
7AEE 2B       DEC HL
7AEF FECD     CP CD
7AF1 20F8     JR NZ,7AEC
7AF3 2B       DEC HL
7AF4 FECD     CP CD
7AF6 20F8     JR NZ,7AF1
7AF8 2B       DEC HL
7AF9 FECD     CP CD
7AFB 20F8     JR NZ,7AF6
7AFD 2B       DEC HL
7AFE FECD     CP CD
7B00 20F8     JR NZ,7AFB
7B02 2B       DEC HL
7B03 FECD     CP CD
7B05 20F8     JR NZ,7B00
7B07 2B       DEC HL
7B08 FECD     CP CD
7B0A 20F8     JR NZ,7B05
7B0C 2B       DEC HL
7B0D FECD     CP CD
7B0F 20F8     JR NZ,7B0A
7B11 2B       DEC HL
7B12 FECD     CP CD
7B14 20F8     JR NZ,7B0F
7B16 2B       DEC HL
7B17 FECD     CP CD
7B19 20F8     JR NZ,7B14
7B1B 2B       DEC HL
7B1C FECD     CP CD
7B1E 20F8     JR NZ,7B19
7B20 2B       DEC HL
7B21 FECD     CP CD
7B23 20F8     JR NZ,7B1E
7B25 2B       DEC HL
7B26 FECD     CP CD
7B28 20F8     JR NZ,7B23
7B2A 2B       DEC HL
7B2B FECD     CP CD
7B2D 20F8     JR NZ,7B28
7B2F 2B       DEC HL
7B30 FECD     CP CD
7B32 20F8     JR NZ,7B2D
7B34 2B       DEC HL
7B35 FECD     CP CD
7B37 20F8     JR NZ,7B32
7B39 2B       DEC HL
7B3A FECD     CP CD
7B3C 20F8     JR NZ,7B37
7B3E 2B       DEC HL
7B3F FECD     CP CD
7B41 20F8     JR NZ,7B3C
7B43 2B       DEC HL
7B44 FECD     CP CD
7B46 20F8     JR NZ,7B41
7B48 2B       DEC HL
7B49 FECD     CP CD
7B4B 20F8     JR NZ,7B46
7B4D 2B       DEC HL
7B4E FECD     CP CD
7B50 20F8     JR NZ,7B4B
7B52 2B       DEC HL
7B53 FECD     CP CD
7B55 20F8     JR NZ,7B50
7B57 2B       DEC HL
7B58 FECD     CP CD
7B5A 20F8     JR NZ,7B55
7B5C 2B       DEC HL
7B5D FECD     CP CD
7B5F 20F8     JR NZ,7B5A
7B61 2B       DEC HL
7B62 FECD     CP CD
7B64 20F8     JR NZ,7B5F
7B66 2B       DEC HL
7B67 FECD     CP CD
7B69 20F8     JR NZ,7B64
7B6B 2B       DEC HL
7B6C FECD     CP CD
7B6E 20F8     JR NZ,7B69
7B70 2B       DEC HL
7B71 FECD     CP CD
7B73 20F8     JR NZ,7B6E
7B75 2B       DEC HL
7B76 FECD     CP CD
7B78 20F8     JR NZ,7B73
7B7A 2B       DEC HL
7B7B FECD     CP CD
7B7D 20F8     JR NZ,7B78
7B7F 2B       DEC HL
7B80 FECD     CP CD
7B82 20F8     JR NZ,7B7D
7B84 2B       DEC HL
7B85 FECD     CP CD
7B87 20F8     JR NZ,7B82
7B89 2B       DEC HL
7B8A FECD     CP CD
7B8C 20F8     JR NZ,7B87
7B8E 2B       DEC HL
7B8F FECD     CP CD
7B91 20F8     JR NZ,7B8C
7B93 2B       DEC HL
7B94 FECD     CP CD
7B96 20F8     JR NZ,7B91
7B98 2B       DEC HL
7B99 FECD     CP CD
7B9B 20F8     JR NZ,7B96
7B9D 2B       DEC HL
7B9E FECD     CP CD
7BA0 20F8     JR NZ,7B9B
7BA2 2B       DEC HL
7BA3 FECD     CP CD
7BA5 20F8     JR NZ,7BA0
7BA7 2B       DEC HL
7BA8 FECD     CP CD
7BAA 20F8     JR NZ,7BA3
7BAC 2B       DEC HL
7BAD FECD     CP CD
7BAF 20F8     JR NZ,7BA8
7BB1 2B       DEC HL
7BB2 FECD     CP CD
7BB4 20F8     JR NZ,7BAD
7BB6 2B       DEC HL
7BB7 FECD     CP CD
7BB9 20F8     JR NZ,7BB2
7BBB 2B       DEC HL
7BBC FECD     CP CD
7BBE 20F8     JR NZ,7BB7
7BC0 2B       DEC HL
7BC1 FECD     CP CD
7BC3 20F8     JR NZ,7BBC
7BC5 2B       DEC HL
7BC6 FECD     CP CD
7BC8 20F8     JR NZ,7BC1
7BCA 2B       DEC HL
7BCB FECD     CP CD
7BCD 20F8     JR NZ,7BC6
7BCF 2B       DEC HL
7BD0 FECD     CP CD
7BD2 20F8     JR NZ,7BCB
7BD4 2B       DEC HL
7BD5 FECD     CP CD
7BD7 20F8     JR NZ,7BD0
7BD9 2B       DEC HL
7BDA FECD     CP CD
7BDC 20F8     JR NZ,7BD5
7BDE 2B       DEC HL
7BDF FECD     CP CD
7BE1 20F8     JR NZ,7BDA
7BE3 2B       DEC HL
7BE4 FECD     CP CD
7BE6 20F8     JR NZ,7BDF
7BE8 2B       DEC HL
7BE9 FECD     CP CD
7BEB 20F8     JR NZ,7BE4
7BED 2B       DEC HL
7BEE FECD     CP CD
7BF0 20F8     JR NZ,7BE9
7BF2 2B       DEC HL
7BF3 FECD     CP CD
7BF5 20F8     JR NZ,7BEE
7BF7 2B       DEC HL
7BF8 FECD     CP CD
7BFA 20F8     JR NZ,7BF3
7BFC 2B       DEC HL
7BFD FECD     CP CD
7BFF 20F8     JR NZ,7BF8
7C01 2B       DEC HL
7C02 FECD     CP CD
7C04 20F8     JR NZ,7BFD
7C06 2B       DEC HL
7C07 FECD     CP CD
7C09 20F8     JR NZ,7C02
7C0B 2B       DEC HL
7C0C FECD     CP CD
7C0E 20F8     JR NZ,7C07
7C10 2B       DEC HL
7C11 FECD     CP CD
7C13 20F8     JR NZ,7C0C
7C15 2B       DEC HL
7C16 FECD     CP CD
7C18 20F8     JR NZ,7C11
7C1A 2B       DEC HL
7C1B FECD     CP CD
7C1D 20F8     JR NZ,7C16
7C1F 2B       DEC HL
7C20 FECD     CP CD
7C22 20F8     JR NZ,7C1B
7C24 2B       DEC HL
7C25 FECD     CP CD
7C27 20F8     JR NZ,7C20
7C29 2B       DEC HL
7C2A FECD     CP CD
7C2C 20F8     JR NZ,7C25
7C2E 2B       DEC HL
7C2F FECD     CP CD
7C31 20F8     JR NZ,7C2A
7C33 2B       DEC HL
7C34 FECD     CP CD
7C36 20F8     JR NZ,7C2F
7C38 2B       DEC HL
7C39 FECD     CP CD
7C3B 20F8     JR NZ,7C34
7C3D 2B       DEC HL
7C3E FECD     CP CD
7C40 20F8     JR NZ,7C39
7C42 2B       DEC HL
7C43 FECD     CP CD
7C45 20F8     JR NZ,7C3E
7C47 2B       DEC HL
7C48 FECD     CP CD
7C4A 20F8     JR NZ,7C43
7C4C 2B       DEC HL
7C4D FECD     CP CD
7C4F 20F8     JR NZ,7C48
7C51 2B       DEC HL
7C52 FECD     CP CD
7C54 20F8     JR NZ,7C4D
7C56 2B       DEC HL
7C57 FECD     CP CD
7C59 20F8     JR NZ,7C52
7C5B 2B       DEC HL
7C5C FECD     CP CD
7C5E 20F8     JR NZ,7C57
7C60 2B       DEC HL
7C61 FECD     CP CD
7C63 20F8     JR NZ,7C5C
7C65 2B       DEC HL
7C66 FECD     CP CD
7C68 20F8     JR NZ,7C61
7C6A 2B       DEC HL
7C6B FECD     CP CD
7C6D 20F8     JR NZ,7C66
7C6F 2B       DEC HL
7C70 FECD     CP CD
7C72 20F8     JR NZ,7C6B
7C74 2B       DEC HL
7C75 FECD     CP CD
7C77 20F8     JR NZ,7C70
7C79 2B       DEC HL
7C7A FECD     CP CD
7C7C 20F8     JR NZ,7C75
7C7E 2B       DEC HL
7C7F FECD     CP CD
7C81 20F8     JR NZ,7C7A
7C83 2B       DEC HL
7C84 FECD     CP CD
7C86 20F8     JR NZ,7C7F
7C88 2B       DEC HL
7C89 FECD     CP CD
7C8B 20F8     JR NZ,7C84
7C8D 2B       DEC HL
7C8E FECD     CP CD
7C90 20F8     JR NZ,7C89
7C92 2B       DEC HL
7C93 FECD     CP CD
7C95 20F8     JR NZ,7C8E
7C97 2B       DEC HL
7C98 FECD     CP CD
7C9A 20F8     JR NZ,7C93
7C9C 2B       DEC HL
7C9D FECD     CP CD
7C9F 20F8     JR NZ,7C98
7CA1 2B       DEC HL
7CA2 FECD     CP CD
7CA4 20F8     JR NZ,7C9D
7CA6 2B       DEC HL
7CA7 FECD     CP CD
7CA9 20F8     JR NZ,7CA2
7CAB 2B       DEC HL
7CAC FECD     CP CD
7CAE 20F8     JR NZ,7CA7
7CB0 2B       DEC HL
7CB1 FECD     CP CD
7CB3 20F8     JR NZ,7CAC
7CB5 2B       DEC HL
7CB6 FECD     CP CD
7CB8 20F8     JR NZ,7CB1
7CBA 2B       DEC HL
7CBB FECD     CP CD
7CBD 20F8     JR NZ,7CB6
7CBF 2B       DEC HL
7CC0 FECD     CP CD
7CC2 20F8     JR NZ,7CBB
7CC4 2B       DEC HL
7CC5 FECD     CP CD
7CC7 20F8     JR NZ,7CC0
7CC9 2B       DEC HL
7CCA FECD     CP CD
7CCC 20F8     JR NZ,7CC5
7CCE 2B       DEC HL
7CCF FECD     CP CD
7CD1 20F8     JR NZ,7CCA
7CD3 2B       DEC HL
7CD4 FECD     CP CD
7CD6 20F8     JR NZ,7CCF
7CD8 2B       DEC HL
7CD9 FECD     CP CD
7CDB 20F8     JR NZ,7CD4
7CDD 2B       DEC HL
7CDE FECD     CP CD
7CE0 20F8     JR NZ,7CD9
7CE2 2B       DEC HL
7CE3 FECD     CP CD
7CE5 20F8     JR NZ,7CDE
7CE7 2B       DEC HL
7CE8 FECD     CP CD
7CEA 20F8     JR NZ,7CE3
7CEC 2B       DEC HL
7CED FECD     CP CD
7CEF 20F8     JR NZ,7CE8
7CF1 2B       DEC HL
7CF2 FECD     CP CD
7CF4 20F8     JR NZ,7CED
7CF6 2B       DEC HL
7CF7 FECD     CP CD
7CF9 20F8     JR NZ,7CF2
7CFB 2B       DEC HL
7CFC FECD     CP CD
7CFE 20F8     JR NZ,7CF7
7D00 2B       DEC HL
7D01 FECD     CP CD
7D03 20F8     JR NZ,7CFC
7D05 2B       DEC HL
7D06 FECD     CP CD
7D08 20F8     JR NZ,7D01
7D0A 2B       DEC HL
7D0B FECD     CP CD
7D0D 20F8     JR NZ,7D06
7D0F 2B       DEC HL
7D10 FECD     CP CD
7D12 20F8     JR NZ,7D0B
7D14 2B       DEC HL
7D15 FECD     CP CD
7D17 20F8     JR NZ,7D10
7D19 2B       DEC HL
7D1A FECD     CP CD
7D1C 20F8     JR NZ,7D15
7D1E 2B       DEC HL
7D1F FECD     CP CD
7D21 20F8     JR NZ,7D1A
7D23 2B       DEC HL
7D24 FECD     CP CD
7D26 20F8     JR NZ,7D1F
7D28 2B       DEC HL
7D29 FECD     CP CD
7D2B 20F8     JR NZ,7D24
7D2D 2B       DEC HL
7D2E FECD     CP CD
7D30 20F8     JR NZ,7D29
7D32 2B       DEC HL
7D33 FECD     CP CD
7D35 20F8     JR NZ,7D2E
7D37 2B       DEC HL
7D38 FECD     CP CD
7D3A 20F8     JR NZ,7D33
7D3C 2B       DEC HL
7D3D FECD     CP CD
7D3F 20F8     JR NZ,7D38
7D41 2B       DEC HL
7D42 FECD     CP CD
7D44 20F8     JR NZ,7D3D
7D46 2B       DEC HL
7D47 FECD     CP CD
7D49 20F8     JR NZ,7D42
7D4B 2B       DEC HL
7D4C FECD     CP CD
7D4E 20F8     JR NZ,7D47
7D50 2B       DEC HL
7D51 FECD     CP CD
7D53 20F8     JR NZ,7D4C
7D55 2B       DEC HL
7D56 FECD     CP CD
7D58 20F8     JR NZ,7D51
7D5A 2B       DEC HL
7D5B FECD     CP CD
7D5D 20F8     JR NZ,7D56
7D5F 2B       DEC HL
7D60 FECD     CP CD
7D62 20F8     JR NZ,7D5B
7D64 2B       DEC HL
7D65 FECD     CP CD
7D67 20F8     JR NZ,7D60
7D69 2B       DEC HL
7D6A FECD     CP CD
7D6C 20F8     JR NZ,7D65
7D6E 2B       DEC HL
7D6F FECD     CP CD
7D71 20F8     JR NZ,7D6A
7D73 2B       DEC HL
7D74 FECD     CP CD
7D76 20F8     JR NZ,7D6F
7D78 2B       DEC HL
7D79 FECD     CP CD
7D7B 20F8     JR NZ,7D74
7D7D 2B       DEC HL
7D7E FECD     CP CD
7D80 20F8     JR NZ,7D79
7D82 2B       DEC HL
7D83 FECD     CP CD
7D85 20F8     JR NZ,7D7E
7D87 2B       DEC HL
7D88 FECD     CP CD
7D8A 20F8     JR NZ,7D83
7D8C 2B       DEC HL
7D8D FECD     CP CD
7D8F 20F8     JR NZ,7D88
7D91 2B       DEC HL
7D92 FECD     CP CD
7D94 20F8     JR NZ,7D8D
7D96 2B       DEC HL
7D97 FECD     CP CD
7D99 20F8     JR NZ,7D92
7D9B 2B       DEC HL
7D9C FECD     CP CD
7D9E 20F8     JR NZ,7D97
7DA0 2B       DEC HL
7DA1 FECD     CP CD
7DA3 20F8     JR NZ,7D9C
7DA5 2B       DEC HL
7DA6 FECD     CP CD
7DA8 20F8     JR NZ,7DA1
7DAA 2B       DEC HL
7DAB FECD     CP CD
7DAD 20F8     JR NZ,7DA6
7DAF 2B       DEC HL
7DB0 FECD     CP CD
7DB2 20F8     JR NZ,7DAB
7DB4 2B       DEC HL
7DB5 FECD     CP CD
7DB7 20F8     JR NZ,7DB0
7DB9 2B       DEC HL
7DBA FECD     CP CD
7DBC 20F8     JR NZ,7DB5
7DBE 2B       DEC HL
7DBF FECD     CP CD
7DC1 20F8     JR NZ,7DBA
7DC3 2B       DEC HL
7DC4 FECD     CP CD
7DC6 20F8     JR NZ,7DBF
7DC8 2B       DEC HL
7DC9 FECD     CP CD
7DCB 20F8     JR NZ,7DC4
7DCD 2B       DEC HL
7DCE FECD     CP CD
7DD0 20F8     JR NZ,7DC9
7DD2 2B       DEC HL
7DD3 FECD     CP CD
7DD5 20F8     JR NZ,7DCE
7DD7 2B       DEC HL
7DD8 FECD     CP CD
7DDA 20F8     JR NZ,7DD3
7DDC 2B       DEC HL
7DDD FECD     CP CD
7DDF 20F8     JR NZ,7DD8
7DE1 2B       DEC HL
7DE2 FECD     CP CD
7DE4 20F8     JR NZ,7DDD
7DE6 2B       DEC HL
7DE7 FECD     CP CD
7DE9 20F8     JR NZ,7DE2
7DEB 2B       DEC HL
7DEC FECD     CP CD
7DEE 20F8     JR NZ,7DE7
7DF0 2B       DEC HL
7DF1 FECD     CP CD
7DF3 20F8     JR NZ,7DEC
7DF5 2B       DEC HL
7DF6 FECD     CP CD
7DF8 20F8     JR NZ,7DF1
7DFA 2B       DEC HL
7DFB FECD     CP CD
7DFD 20F8     JR NZ,7DF6
7DFF 2B       DEC HL
7E00 FECD     CP CD
7E02 20F8     JR NZ,7DFB
7E04 2B       DEC HL
7E05 FECD     CP CD
7E07 20F8     JR NZ,7E00
7E09 2B       DEC HL
7E0A FECD     CP CD
7E0C 20F8     JR NZ,7E05
7E0E 2B       DEC HL
7E0F FECD     CP CD
7E11 20F8     JR NZ,7E0A
7E13 2B       DEC HL
7E14 FECD     CP CD
7E16 20F8     JR NZ,7E0F
7E18 2B       DEC HL
7E19 FECD     CP CD
7E1B 20F8     JR NZ,7E14
7E1D 2B       DEC HL
7E1E FECD     CP CD
7E20 20F8     JR NZ,7E19
7E22 2B       DEC HL
7E23 FECD     CP CD
7E25 20F8     JR NZ,7E1E
7E27 2B       DEC HL
7E28 FECD     CP CD
7E2A 20F8     JR NZ,7E23
7E2C 2B       DEC HL
7E2D FECD     CP CD
7E2F 20F8     JR NZ,7E28
7E31 2B       DEC HL
7E32 FECD     CP CD
7E34 20F8     JR NZ,7E2D
7E36 2B       DEC HL
7E37 FECD     CP CD
7E39 20F8     JR NZ,7E32
7E3B 2B       DEC HL
7E3C FECD     CP CD
7E3E 20F8     JR NZ,7E37
7E40 2B       DEC HL
7E41 FECD     CP CD
7E43 20F8     JR NZ,7E3C
7E45 2B       DEC HL
7E46 FECD     CP CD
7E48 20F8     JR NZ,7E41
7E4A 2B       DEC HL
7E4B FECD     CP CD
7E4D 20F8     JR NZ,7E46
7E4F 2B       DEC HL
7E50 FECD     CP CD
7E52 20F8     JR NZ,7E4B
7E54 2B       DEC HL
7E55 FECD     CP CD
7E57 20F8     JR NZ,7E50
7E59 2B       DEC HL
7E5A FECD     CP CD
7E5C 20F8     JR NZ,7E55
7E5E 2B       DEC HL
7E5F FECD     CP CD
7E61 20F8     JR NZ,7E5A
7E63 2B       DEC HL
7E64 FECD     CP CD
7E66 20F8     JR NZ,7E5F
7E68 2B       DEC HL
7E69 FECD     CP CD
7E6B 20F8     JR NZ,7E64
7E6D 2B       DEC HL
7E6E FECD     CP CD
7E70 20F8     JR NZ,7E69
7E72 2B       DEC HL
7E73 FECD     CP CD
7E75 20F8     JR NZ,7E6E
7E77 2B       DEC HL
7E78 FECD     CP CD
7E7A 20F8     JR NZ,7E73
7E7C 2B       DEC HL
7E7D FECD     CP
```

(continued from previous page)

```
7D78  3E13777A  DEFB
7D7C  450092C5  DEFB
7D80  9E584513  DEFB
7D84  15AAC56A  DEFB
7D88  1372450B  DEFB
7D8C  07B2C507  DEFB
7D90  0B7FE882  DEFB
7D94  87CB625C  DEFB
7D98  2F90585B  DEFB
7D9C  7F467E81  DEFB
7DA0  00FA3E86  DEFB
7DA4  7A438692  DEFB
7DA8  C56AFF5F  DEFB
7DAC  6A7A3B86  DEFB
7DB0  92C56A7F  DEFB
7DB4  467E829E  DEFB
7DB8  CF92007A  DEFB
7DBC  A12F8AC5  DEFB
7DC0  007AA42F  DEFB
7DC4  6AC5007A  DEFB
7DC8  A72F8AC5  DEFB
7DCC  007A6300  DEFB
7DD0  92C5AA52  DEFB
7DD4  62AA8AC5  DEFB
7DD8  00506215  DEFB
7DDC  A2C5136A  DEFB
7DE0  45111139A  DEFB
7DE4  C51311100  DEFB
7DE8  6A3E50FA  DEFB
7DEC  66B87FEC  DEFB
7DF0  C487D5B9  DEFB
7DF4  E1D7BCE2  DEFB
7DF8  D7FA1900  DEFB
7DFC  D637136A  DEFB
7E00  00000000  DEFB
7E04  322A33BA  DEFB
7E08  00000000  DEFB
7E0C  14141494  DEFB
7E10  1C003537  DEFB
7E14  2E333900  DEFB
7E18  283429AA  DEFB
7E1C  1D003537  DEFB
7E20  2E333900  DEFB
7E24  292639A5  DEFB
7E28  1E003C37  DEFB
7E2C  2E33AA1F  DEFB
7E30  002E3338  DEFB
7E34  2A37B920  DEFB
7E38  00292A31  DEFB
7E3C  2A39AA21  DEFB
7E40  00393726  DEFB
7E44  33382B2A  DEFB
7E48  B7220038  DEFB
7E4C  2A263728  DEFB
7E50  AD230037  DEFB
7E54  2A353126  DEFB
7E58  28AA2400  DEFB
7E5C  373A3300  DEFB
7E60  283429AA  DEFB
7E64  25802580  DEFB
7E68  27802580  DEFB
7E6C  29802580  DEFB
7E70  28808080  DEFB
7ED0  312E322E  DEFB
7ED4  B937343A  DEFB
7ED8  391D332A  DEFB
7EDC  80383926  DEFB
7EE0  37398026  DEFB
7EE4  2929372A  DEFB
7EE8  36386026  DEFB
7EEC  2E332E38  DEFB
7EF0  2D601D00  DEFB
7EF4  2B343780  DEFB
7EF8  35372E33  DEFB
7EFC  392A3780  DEFB
7F00  23782379  DEFB
7F04  53782378  DEFB
7F08  23782378  DEFB
7F0C  23782378  DEFB
7F10  23782378  DEFB
7F14  23782378  DEFB
7F18  23782378  DEFB
7F1C  23782378  DEFB
```

(listing continued from previous page)

```
7F20 DE        PUSH DE
7F21 E5        PUSH HL
7F22 2A2540    LD   HL,(4025)
7F25 E5        PUSH HL
7F26 ED4B2540  LD   BC,(4025)
7F2A E1        POP  HL
7F2B C5        PUSH BC
7F2C 8D        ADC  A,L
7F2D 6D42      SBC  HL,BC
7F30 28F8      JR   Z,7F2A
7F32 47        LD   B,A
7F33 1F        RRCA
7F34 38F1      JR   C,7F27
7F36 E1        POP  HL
7F37 CDBD07    CALL 07BD
7F3A 7E        LD   A,(HL)
7F3B E1        POP  HL
7F3C D1        POP  DE
7F3D C1        POP  BC
7F3E 76        HALT
7F3F CE76      ADC  A,76
7F41 27        DAA
7F42 CF        RST  8
7F43 C8        RET  Z
7F44 2D0C      DEC  C
7F46 20DB      JR   NZ,7F4D
7F48 CD2A0A    CALL 0A2A
7F4B CF        RST  8
7F4C DEFD      SBC  A,FD
7F4E 1C        INC  E
7F4F 38CF      JR   C,7F20
7F51 BC        CP   H
7F52 38CB      JR   NC,7F20
7F54 C9        RET
7F55 212140    LD   HL,4021
7F58 CB7E      BIT  7,(HL)
7F5B 28FA      JR   Z,7F55
7F5D 2A7B40    LD   HL,(407B)
7F60 E9        JP   (HL)
7F61 21907E    LD   HL,7E90
7F64 0614      LD   B,14
7F66 7E        LD   A,(HL)
7F67 32B140    LD   (40B1),A
7F6A 11E110    LD   DE,10E1
7F6D CDF78    CALL 78F7
7F71 CD5378    CALL 7853
7F74 10F6      DJNZ 7F6C
7F76 019978    LD   BC,7899
7F79 CD5378    CALL 7853
7F7C 2B        DEC  HL
7F7D 7E        LD   A,(HL)
7F7E D61C      SUB  1C
7F80 47        LD   B,A
7F81 CB27      SLA  A
7F83 87        ADD  A,A
7F84 87        ADD  A,A
7F85 257F      LD   H,7F
7F87 6F        LD   L,A
7F88 23        INC  HL
7F89 7E        LD   A,(HL)
7F8A 6F        LD   L,A
7F8B 67        PUSH HL
7F8C E5        PUSH HL
7F8D CD2A0A    CALL 0A2A
7F90 C1        POP  BC
7F91 DEFB      SBC  A,EB
7F93 5F        LD   E,A
7F94 78        LD   A,B
7F95 21187E    LD   HL,7E18
7F98 CDAD78    CALL 78AD
7F9B 161A      LD   D,1A
7F9D CD5378    CALL 7853
7FA0 0E76      LD   C,76
7FA2 D7        RST  10
7FA3 D7        RST  10
7FA4 C9        RET
7FA5 3E01      LD   A,01
7FA7 32B140    LD   (40B1),A
7FAA 21E07F    LD   HL,7FE0
7FAD 0E0F      LD   C,0F
7FAF CDCD7C    CALL 7CCD
7FB2 CD287F    CALL 7F28
7FB5 F6        OR   76
7FB7 2810      JR   NZ,7FC9
7FB9 3E10      LD   A,10
7FBB 86        ADD  A,(HL)
7FBC 77        LD   (HL),A
7FBD 2A        LD   HL,(
7FBE 3500      DEC  (HL)
7FC0 23        INC  HL
7FC1 20367D    LD   (7D36),HL
7FC4 CD5378    CALL 7853
7FC7 2B        DEC  HL
7FC8 C9        RET
7FC9 FE27      CP   27
7FCB 20DB      JR   NZ,7FD8
7FCD 2A        LD   HL,(
7FCE 6D        LD   L,L
7FCF 2608      LD   H,08
7FD1 2B        DEC  HL
7FD2 CD287F    CALL 7F28
7FD5 2B        DEC  HL
7FD6 1606      LD   D,06
7FD8 77        LD   (HL),A
7FD9 7B        LD   A,E
7FDA 2B        DEC  HL
7FDB 20D0      JR   Z,7FAD
7FDD 2B        DEC  HL
7FDE 18CD      JR   7FAD
```

Table 1. Memory map showing main routines only.

Address	Mnemonic	Comments
07BD	Decode	Finds keyboard character code; ROM.
0A2A	Cls	Clears screen; ROM.
0B6B	Print Str$	Prints mnemonic string; ROM
0C0E	Scroll	Moves display up on line; ROM.
4021	Flag Y	Bit 0-change print position; Bit 1-Print Newline Bit 2-dump to printer; Bit 7-change restart address.
407B	Restart	Contains restart address following full screen and cont command.
7400		Spare
7822		bytes
7823	Routine 0	Disassembler
78E7		Spare
78FC		bytes
78FD	Start/finish addresses	Print request for input and then call input address routine.
7902	A addresses	Print request for the number of addresses specified by register A then call input address.
7909	Check printer	Sets Bit 1 of FLAGS — 4001 — if printer required.
7920	Routine 1	Prints data.
7953	Routine 2	Write.
7983	DEFB	prints data associated with RST 08 and RSt 28 instructions.
79C7	Data	Calculates absolute address for JR instructions and adds number and addresses to mnemonic.
7A14	Input address	Input one address and store in memory.
7A2E	Initial	Sets data at commencement of disassembling each instruction.
7A3D	Next address	Prints next address in Hex.
7A4F	Octal	Converts binary number to octal.
7A62	Cont RST	Called if screen full during decoding of RST 08 or RST 28
7A72	Next byte	prints a byte of instruction.
7A9D	Offsets	Various routines to find mnemonic data. Called from control.
7AD4	Control	Master routine in disassembler.
7B0B	Transfer	Moves data around memory.
7B53	Print string	Main print routine.
7B81	Check finish	Used to determine end of routine.
7B93 — 7B9E		Data for input prompt messages.
7B9F	Add String	A number of routines to built up mnemonic.
7C00 — 7CFF		Data for mnemonics.
7D00 — 7DFF		Data and data pointers for disassembler.
7E00 — 7EFF		Print data for menu and routines
7F00 — 7F1F		Addresses of routines
7F20	keyboard	Reads keyboard.
7F56	menu	
7FA5	input string	heart of all input routines.
7FE0 — 7FEF	mnemonic string	holds instruction mnemonic as it is built up.
7FF0 — 7FF7		Spare bytes.
7FF8	next	Contains next address for routine.
7FFA	finish	Contains finish address for routine.
7FFC — 7FFF		Spare bytes

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VIC-20

The first demonstration program.

```
0 GOSUB40
1 DATA225,231,235,240,
   209,219,225,232,225,231,235,
   240,215,223,228,235:RESTORE
2 FORA=1TO4
3 FORB=1TO4
4 READB(A,B)
5 NEXTB,A
9 POKE36878,15
10 DIMC(4,4),D(4,4)
20 DATA195,215,195,219,195,
   221,195,219
21 DATA209,225,209,228,209,
   229,209,228
22 DATA195,215,195,219,195,
   221,195,219
23 DATA175,201,175,207,175,
   209,175,207
24 REM***************
25 FORA=1TO4
26 FORB=1TO4
27 READC(A,B),D(A,B)
28 NEXTB,A
29 DEL=220
30 FORA=1TO4
31 FORB=1TO2
32 FORC=1TO4
33 POKE36874,C(A,C)
34 POKE36875,D(A,C):POKE36876,
   B(A,INT(RND(TI)*4+1)):GOSUB70
35 FORD=1TODEL:NEXT:POKE36874,
   0:POKE36875,0
36 NEXTC,B,A
37 GOTO30
40 POKE36879,8:PRINT"□■    THE VIC BOOGIE"
50 PRINT"                    "
60 PRINT"XXBY:":PRINT"XXXA.MACIELINSKI":PRINT"
   XXXXXXXXXX                    ":RETURN
70 PRINT"XXXXXXXXX
```

(continued from previous page)

Note	Value
C	225
E	231
G	235
top C	240

In both demonstration programs the right-hand notes are handled by a Dim statement and are played randomly by using

INT(RND(TI)*4)+1

The TI ensures that a totally random number is produced. This method then produces a totally random tune together with the main left-hand chords, using all three sound generators.

The second demonstration program uses a more complicated set of chords which produces a mixture of two or three sound generators going on at once. This is because the first four notes in the left-hand Dim statement were all more than 0, whereas the rest of the Dim contained half 0s and half proper notes. This creates an interesting effect and the contrast between two-part harmony and three-part harmony shows well.

With a lot of experimentation — unless you have a piano or a similar instrument — you could produce your own tunes and left-hand chords. Perhaps you could even add a little white noise to the tune to give it an alien, sinister quality.

I would advise against turning up the volume too far: quite apart from the neighbours, the faithful old TV cannot stand the wear and tear that multi-harmony tunes can produce. So just remember to play it cool.

The second demonstration program.

```
1 DIMA(4,4),B(4,8),C(4,8)
2 DATA225,231,235,240,209,219,225,232,225,231,235,240,215,223,228,
  235
3 FORA=1TO4
4 FORB=1TO4
5 READA(A,B)
6 NEXTB,A
7 FORA=1TO4
8 FORB=1TO8
9 READB(A,B),C(A,B)
10 NEXTB,A
11 DATA195,215,195,215,0,203,0,207,0,215,0,215,0,203,0,207
12 DATA209,225,209,225,0,217,0,219,0,225,0,225,0,217,0,219
13 DATA195,215,195,215,0,203,0,207,0,215,0,215,0,203,0,207
14 DATA175,201,175,201,0,187,0,191,0,201,0,201,0,187,0,191
20 POKE36879,8:PRINT"■    VIC BOOGIE II":PRINT"
21 PRINT"BY:":PRINT"A.MACIELINSKI":POKE36878,15:DEL=150
22 PRINT"
23 PRINT"
24 PRINT"
25 PRINT"
26 PRINT"TRASH BIN"
30 FORA=1TO4
31 FORB=1TO2
32 FORC=1TO8
33 POKE36874,B(A,C)
34 POKE36875,C(A,C)
35 POKE36876,A(A,INT(RND(TI)*4+1)):GOSUB40
36 FORF=1TODEL:NEXT
37 POKE36874,0:POKE36875,0
38 NEXTC,B,A
39 GOTO30
40 PRINT"";
41 IFC=1ORC=5THENPRINT"
42 IFC=2ORC=6THENPRINT"
43 IFC=3ORC=7THENPRINT"
44 IFC=4ORC=8THENPRINT"
45 RETURN
```


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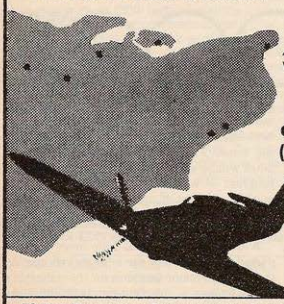

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Figure 1. A listing of routines used in the machine code with the Start addresses. The machine code is in the form of a decimal dump in blocks of six bytes with the Start address of each block given.

Start address	Routine
29666	Check and accept 0-255 and Print keys pressed in Input lines.
29859	Pause until key pressed. Uses Halt command.
29871	Check last key press.
29900	Check number selected with menu options 1, 3 and 6.
29951	Main typewriter calls for un-shifted and single shifted keys.
29971	Double-shifted key calls.
29978	Print 8 × and 1 × size redefined characters.
30076	Print Spectrum and "new" redefined characters.
30157	Print "decimal-number" prompt.
30182	Print screen format for Redefine Mode.
30364	Print instructions routines.
30774	Data for sub-menu.
30821	Restore character mode in use.
30831	Print sub-menu.
30855	Data for menu.
30986	Print menu.
31013	Set screen and input lines bright.
31027	Erase-a-page start.
31038	Next page.
31067	Data for double-shift alternative character set.
31083	Store character mode in use.
31097	Normal and single-shifted key calls
31177	double-shifted key check and calls.
31214	Justify.
31242	Erase part of a page.
31293	Find cursor.
31316	Rubout.
31350	Justify subroutine.
31493/4/5	Spare.
31496	Data for Justify.
31500	Insert/delete.
31599	Spare.
31600	Find page.
31624	Erase a complete page.
31636	Print a page.
31664	Squeek.
31684	Buzz.
31710/11	Spare.
31712	New character set codes.
32481	Set parameters of page to be printed and call print page.
32489	Spare.
32490	Tap.
32500	Check character to be plotted.
32534	Plot character.
32573	Set Spectrum character mode.
32580	Set new character mode
32587-91	Spare.
32592	Set Over 1 for cursor.
32600	Plot cursor.
32651	Data for cursor position X,Y top left = 1,1.
32653	Cursor handling for Newline, Space, and put character plotted into x$ array.
32692-32767	Cursor keys check and move as required. Uses In function to read keys being pressed instead of Peeking Last Key 23560.
Data	
31616	Page number in use.
32501	Character code of key to be Plotted.
31529	Number of characters to be inserted or deleted.

THIS PROGRAM for the 16K Spectrum started out as a straightforward typewriter program in Basic with approximately 30 bytes of machine code to plot characters on to the screen in such a way as to give 42 characters per line. But the program was slow and used too much RAM, leaving little free for data storage.

The solution was to convert all the routines into machine code and maintain a minimum of four pages of data with 42 characters per line, this being the equivalent of five and a quarter pages of text if the normal 32 characters per line were used.

Up to this point I had been using the Spectrum character set, but the upper-case letters were touching each other and making the text illegible. I added a new character set with all the characters redefined on a six-by-eight pixel format. This created the option of using the Spectrum set or the new typewriter-mode set.

The program starts with the main Menu, which has six options.

The Start option takes you into the typewriter mode. It begins by asking for the page required and printing the selected page. This is done to avoid accidental overtyping of an existing page of text. A cursor is placed in the first character position at the top left of the screen, and can be moved to any position by means of Caps Shift and cursor controls: keys 5-8.

The cursor always indicates the position of the next character to be typed. If the cursor is moved over existing typing the character will change to white Ink and show through the cursor. If a character is overtyped, then it will be printed on top of the existing character, but the last character typed is held in the memory of the computer.

All Spectrum characters are available, using Shift keys as necessary, and all but the double-Shifted ones are auto-repeat.

Incorrect entries can be quickly erased by the use of Caps Shift and Delete. This will erase the character behind the cursor and backspace the cursor over the deleted character. At the start of a line it will erase the last character on the previous line and backspace on to that line. This function is also auto-repeat.

A Newline is obtained by pressing Enter, and this function will also auto-repeat. If the cursor is on line 22 then Enter will move the cursor to the end of line 22 where it is split into two, bracketing the last line, to indicate that the end of the page has been reached.

This method is used to erase the last character on a page, the cursor being in effect after the last character. There are several options available in this mode and, as a guide, these are indicated on line 24, with the keys necessary for each option shown in inverse video. The next options require both Shift keys to be pressed before the option letter. First, n(ext) will scroll the page off the screen and replace it with a copy of the next page. This can be used after finishing typing a page or to read through the pages. If you are on page 4 then the next page will be page 1. Second, m(enu) will take you back to the main Menu. Third, z is the copy key and, as it suggests it will copy the page on the screen to the printer.

A further facility is the Edit mode. This is accessed by Caps Shift and Edit, and when selected will give you five options. These will be printed on line 24 of the screen with the key presses for each option shown in inverse.

Insert — when selecting this option the cursor must be over the first character in the block to be Shifted right. You will be asked how many characters you require to be inserted; this must be in the range 0-255. The decimal number can be entered either with leading zeros like 032 or 006, in which case the Spectrum will atuomatically accept the number without the need for Enter, or as a "normal" number, that is, 32 or 6, in which case, if it is less than 100, the use of Enter is required. Each key press is checked, a buzz will sound if the entry is not valid and three questionmarks will be printed. A zero entry will skip this routine.

The Basic program.

```
  10 POKE 23606,1: RANDOMIZE USR
 31013: DIM x$(4,924): LET x=0:
LET t=50: LET v=23560: LET a=900
0: GO TO m
  50 RANDOMIZE USR 31083: INPUT
INKEY$: PRINT #x;"Page ";PEEK 3
1819/3; " ";[illegible]x$;[illegible]copy
  55 RANDOMIZE USR 30821
  60 RANDOMIZE USR 29951
 140 IF PEEK v=7 AND PEEK 32651<
>43 THEN GO TO 700
 150 IF PEEK v<>14 THEN GO TO 60
 180 RANDOMIZE USR 29971
 230 IF PEEK v=CODE "n" THEN RAN
DOMIZE USR 31636: GO TO t
 250 IF PEEK v=CODE "m" THEN GO
TO m
 270 GO TO 60
 540 RANDOMIZE USR 31083: INPUT
INKEY$: PRINT #x;"HOW MANY Chrs.
?
 570 RANDOMIZE USR 29566: RANDOM
IZE USR 30821: IF PEEK 29854=x T
HEN GO TO 750
 600 RANDOMIZE USR 31500: GO TO
t
 700 RANDOMIZE USR 32592
 710 RANDOMIZE USR 31083: INPUT
INKEY$: PRINT #x;"Insert;Delete:
[illegible]ase;JUSTIFY[illegible]; L/[illegible]
 730 RANDOMIZE USR 30821: PAUSE
x: IF PEEK v=CODE "i" THEN POKE
31544,10: GO TO 540
 740 IF PEEK v=CODE "d" THEN POK
E 31544,x: GO TO 540
 750 IF PEEK v=CODE "e" THEN RAN
DOMIZE USR 31242: GO TO 750
 760 IF PEEK v=CODE "l" THEN POK
E 31412,79: GO TO 8000
 770 IF PEEK v=CODE "r" THEN POK
E 31412,x: GO TO 8000
 780 RANDOMIZE USR 32592: GO TO
t
1000 RANDOMIZE USR 29900: GO TO
t
2000 RANDOMIZE USR 30434: STOP
3010 GO TO m
3000 RANDOMIZE USR 29915
3020 IF PEEK v>CODE "4" THEN GO
TO m
3050 RANDOMIZE USR 30545: GO TO
3020
4000 RANDOMIZE USR 30615: INPUT
i$
4010 PRINT AT 11,x;"SAVING: """;
i$;"""  DATA x$()": SAVE i$ DATA
x$(): GO TO 5020
5000 RANDOMIZE USR 30674: INPUT
i$
5010 RANDOMIZE USR 30720: PAUSE
x: LOAD i$ DATA x$()
5020 RANDOMIZE USR 30756: PAUSE
x: GO TO m
5000 RANDOMIZE USR 29927
5030 IF PEEK v=CODE "1" THEN RAN
DOMIZE USR 32573: GO TO m
5050 IF PEEK v=CODE "2" THEN RAN
DOMIZE USR 32580: GO TO m
5055 RANDOMIZE USR 30200
5060 INPUT i$
5080 IF LEN i$>1 OR i$<" " OR i$
>"G" THEN RANDOMIZE USR 31684: G
O TO 5060
5085 POKE 30177,CODE i$
5090 RANDOMIZE USR 30076
5100 FOR b=1 TO 8
5110 RANDOMIZE USR 30157
5140 RANDOMIZE USR 29666: RANDOM
IZE USR 29978: NEXT b
5190 PRINT #x;"O.K.? [illegible]epeat :
Other keys MENU" : RANDOMIZE USR
30821: PAUSE x: IF INKEY$="r" TH
EN CLS : GO TO 6055
5200 GO TO m
6000 RANDOMIZE USR 31083: INPUT
INKEY$: PRINT #x;"[illegible]ase OR [illegible]rsor
line ?"
6020 RANDOMIZE USR 30821: PAUSE
x: IF PEEK v=CODE "c" THEN RANDO
MIZE USR 31214: GO TO t
6030 IF PEEK v=CODE "r" THEN RAN
DOMIZE USR 31225: GO TO t
6040 GO TO 780
9000 RANDOMIZE USR 29939: GO TO
1e3+(PEEK v-48)
9800 CLEAR 29665: LOAD ""CODE 29
666: GO TO 10
9900 SAVE "type" LINE 9800: SAVE
 ""CODE 29666,3102
```

WORDS ON THE SPECTRUM

Now's the time to tackle that long-deferred oeuvre with Stuart Nicholls' fast machine-code word processor

The maximum number of characters that can be inserted is one less than the number of characters from the cursor to the end of the page if this is less than 255.

Any character pushed off the page by this routine will be lost. After a number has been accepted the page will scroll off the screen and be replaced instantly with the modified page and the cursor, still in its original position, so that the required information can be typed in.

Delete — this option is similar to Insert in that the cursor is placed over the first character in the block to be deleted, and you will be asked how many characters you require deleting before the page is scrolled off the screen and reprinted with the correction made.

The Erase option will erase part of a page reaching from the end of the page to the line below the cursor. So the cursor must be placed on the last line of typing that you wish to keep before this option is called. The erased part of the page will scroll up and off the screen; the retained part stays in position.

Justify — there are two Justify options, with both you have a further choice of justifying the whole page or the cursor line only. So if only the cursor line is required, be sure to place the cursor anywhere on the required line before this mode is selected. Justify left will scroll the page off the screen and reprint it with the line or page shifted to the left-hand margin. Justify left/right will scroll the page off the screen and reprint it with the line or page shifted left and the space between words padded out so that the last letter of the last word in each line is at the right-hand margin.

These last options can be skipped if the Edit mode is accidentally selected by pressing any other key. The Edit mode cannot be selected with the cursor at the end of the page.

The Stop command stops the program with the usual report and a message that "Continue will restart at Menu". If the program is broken then Goto 9000 will also restart at the menu. If Run is used then all existing typing will be erased.

The Erase-a-page option will ask which page is to be deleted. Any choice other than 1-4 will take you back to the menu. The page selected will be instantly erased.

Pages can be Loaded and Saved on tape with appropriate options. You will be asked to name the pages when Loading and Saving; the usual rule of 10 characters maximum applies.

The Change-typeface option will give you three options: Normal, New and Redefine.

Normal gives typing with the Spectrum characters, but because of the squashed look of the eight-by-eight pixel format, certain characters will look odd.

New: because of the problems outlined above, a new keyboard has been defined to give a six-by-eight character set. When this mode is selected, all typing on the Spectrum will use the new characters, the program listing may be shown in the new characters, but instructions and menus will still use the Spectrum set.

Redefine: any character in the new set can be redefined with this option. The Spectrum will require the character to be redefined and the decimal number of lines 1-8 of the new character. A display will be given showing the Spectrum character selected with the new character beside it; above this will be a grid with lines 1 to 8 and columns a to f indicated. As each decimal number is entered the character will be shown magnified on this grid and the actual size character will alter its shape accordingly.

The character grid is in two colours, yellow and green; the yellow area indicates six columns a to f, and any redefined character should stay within this area as it is only this part of the character that is plotted on the screen.

With this routine the whole keyboard could be redefined to suit your needs. If you want to retain your redefined keyboard then the word processor program will need to be reSaved with the command Goto 9900.

The Spectrum will either buzz if an

(continued on page 88)

Figure 2.

```
1 = 0,0,0,0,0,0,0,0,
2 = 16,16,16,0,0,16,0,0,
3 = 20,20,0,0,0,0,0,0,
4 = 0,40,124,40,124,40,0,0,
5 = 16,56,68,56,20,120,16,0,
6 = 0,100,104,16,44,76,0,0,
7 = 32,80,32,64,72,52,0,0,
8 = 16,16,0,0,0,0,0,0,
9 = 0,16,16,16,16,16,0,0,
10 = 32,16,16,16,16,32,0,0,
11 = 0,40,16,124,16,40,0,0,
12 = 0,16,16,124,16,16,0,0,
13 = 0,0,0,0,0,16,16,0,
14 = 0,0,0,124,0,0,0,0,
15 = 0,0,0,0,0,16,16,0,
16 = 0,4,8,16,32,64,0,0,
17 = 56,76,84,84,100,56,0,0,
18 = 16,48,16,16,16,56,0,0,
19 = 56,68,8,16,32,124,0,0,
20 = 124,4,56,4,4,120,0,0,
21 = 64,72,72,124,8,8,0,0,
22 = 124,64,120,4,4,120,0,0,
23 = 56,64,120,68,68,56,0,0,
24 = 124,4,4,8,16,32,0,0,
25 = 56,68,68,68,68,56,0,0,
26 = 56,68,68,68,4,56,0,0,
27 = 0,16,16,0,16,16,0,0,
28 = 0,16,16,0,16,16,16,0,
29 = 0,16,32,64,32,16,0,0,
30 = 0,0,124,0,124,0,0,0,
31 = 0,16,8,4,8,16,0,0,
32 = 56,68,8,16,0,16,0,0,
33 = 56,76,84,92,64,56,0,0,
34 = 56,68,68,124,68,68,0,0,
35 = 120,68,120,68,68,120,0,0,
36 = 56,68,64,64,68,56,0,0,
37 = 120,68,68,68,68,120,0,0,
38 = 124,64,120,64,64,124,0,0,
39 = 124,64,120,64,64,64,0,0,
40 = 56,68,64,92,68,56,0,0,
41 = 68,68,124,68,68,68,0,0,
42 = 56,16,16,16,16,56,0,0,
43 = 28,8,8,8,72,48,0,0,
44 = 72,80,96,80,72,68,0,0,
45 = 64,64,64,64,64,124,0,0,
46 = 68,108,84,78,68,68,0,0,
47 = 56,68,68,68,68,56,0,0,
48 = 120,68,68,120,64,64,0,0,
49 = 56,68,68,84,56,4,0,0,
50 = 120,68,68,120,72,68,0,0,
51 = 56,64,56,4,68,56,0,0,
52 = 124,16,16,16,16,16,0,0,
53 = 68,68,68,68,68,56,0,0,
54 = 68,68,68,68,40,16,0,0,
55 = 68,68,68,84,84,40,0,0,
56 = 68,40,16,16,40,68,0,0,
57 = 68,40,16,16,16,16,0,0,
58 = 124,8,16,32,64,124,0,0,
59 = 48,32,32,32,32,48,0,0,
60 = 0,64,32,16,8,4,0,0,
61 = 24,8,8,8,8,24,0,0,
62 = 16,56,84,16,16,16,0,0,
63 = 0,0,0,0,0,0,255,
64 = 24,24,24,112,24,24,124,0,
65 = 0,56,68,68,68,68,0,0,
66 = 64,120,68,68,68,120,0,0,
67 = 0,60,64,64,64,60,0,0,
68 = 4,60,68,68,68,60,0,0,
69 = 0,56,68,120,64,56,0,0,
70 = 24,36,32,120,32,32,0,0,
71 = 0,56,68,68,60,4,4,56,
72 = 64,120,68,68,68,68,0,0,
73 = 16,0,48,16,16,56,0,0,
74 = 64,64,72,112,68,68,0,0,
75 = 64,64,64,64,64,56,0,0,
76 = 0,48,84,84,84,84,0,0,
77 = 0,120,68,68,68,68,0,0,
78 = 0,56,68,68,68,56,0,0,
79 = 0,120,68,68,68,120,64,64,
80 = 0,60,68,68,68,60,4,4,
81 = 0,56,64,64,64,64,0,0,
82 = 0,56,64,56,4,120,0,0,
83 = 32,120,32,32,36,24,0,0,
84 = 0,68,68,68,68,56,0,0,
85 = 0,68,68,40,16,0,0,0,
86 = 0,84,84,84,40,40,0,0,
87 = 0,68,40,16,40,68,0,0,
88 = 0,68,68,68,60,4,4,56,
89 = 0,124,8,16,32,124,0,0,
90 = 48,32,32,64,32,32,48,0,
91 = 16,16,16,16,16,16,0,0,
92 = 24,8,8,4,8,8,24,0,
93 = 0,0,52,88,0,0,0,0,
94 = 112,136,252,200,252,136,112,
```

dk'tronics

ZX KEYBOARD FOR USE WITH 80/81 SPECTRUM

Our new cased keyboard has 52 keys, 12 of these are used for the numeric pad. The numeric pad offers some useful features, you can cursor with one hand and it will be a boon for anyone who enters a lot of numeric data. The pad is a repeat of the 1-9 keys plus it has a full stop and a shift key. The numeric pad keys are coloured in red, the normal keyboard keys are grey, with the case being black which makes the whole thing very attractive. The case measures 15 × 9 × 2½ . The computer (either 80/81 or spectrum) fits neatly inside. You will have to remove the computer from its original case, it is then screwed to the base of the case. The case had all the bosses already fitted and the screw holes are marked. Also fitted inside the case is a mother board (81 model only) which allows 16K, 32K and 64K to be fitted in the case. All the connections are at the rear of the case i.e. Power, Mic, Ear, T.V. and the expansion port. The case is large enough for other add ons also to be fitted inside. One of these could be the power supply, then you could very quickly fit a mains switch, or a switch on the 9V line. This means you have a very smart self-contained unit. This case does not stop you from using any other add-ons that you may have e.g. Printer etc. We are convinced that this is the best keyboard available at present. It offers more keys and features than any other keyboard in its price range.

£45

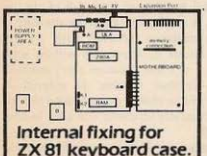
KEYBOARD (SPECTRUM/81)

NOTE

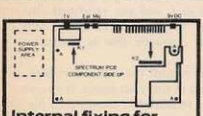
The case can be purchased separately with the keyboard aperture uncut, so if you have one of our early uncased keyboards, or in fact any other suppliers' keyboards, these could be fitted. The keyboard is connected to your computer by a ribbon cable and this has connectors fitted which simply push into the Sinclair connectors. It is a simple two minute job and requires no electronic skills. This keyboard does not need any soldering. Please specify on order whether you require the ZX 81 or Spectrum case.

SPECTRUM MODEL

This is supplied with spectrum legends, and a slightly different base for fitting the spectrum inside, again all the connectors are at the rear of the case and there is plenty of room for the power supply (and other add-ons). Should you want to change, we can supply both the Spectrum legends and details of updating your case which will enable modification from the ZX 81 to spectrum. PLEASE specify on your order whether you require the ZX 81 or spectrum case.



Internal fixing for ZX 81 keyboard case.



Internal fixing for spectrum keyboard case.

SPECTRUM LIGHT PEN

The pen enables you to produce high resolution drawings on your own television set, saving a vast amount of time over using basic programming statements, such as Plot, Draw etc. You can erase, modify and save drawings and it comes complete with software program. The superb light pen is available from D.K. tronics.

£19.95

SPECTR

16K Memory Exp

The 16K uses 4116 Static Ram and occ using the Static Ra speed low power R the computer. All which comes to yo where. Position in

64K Memory Exp

All the above infor advantage lies in th 56K of usable mem the use of other ad 8192-65536. The Bl

Spectrum Memor

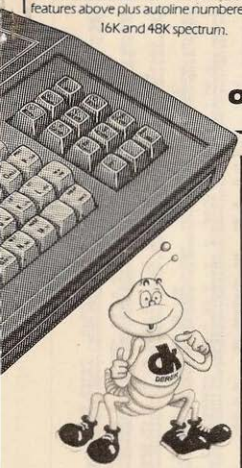
Upgrade your Spec it is simply slipped i are supplied, and t time. The fitting re same as Sinclair's u

ZX 80~81 Spectrum HARDWARE

SPECTRUM/81 TOOLKIT

This is the toolkit which won acclaim in the feature in the August 1982 issue (pages 29 and 30) of Sinclair User. "It is the most impressive program, fast in execution with clear and full instructions...it stands out from the rest of the field." The ZXED is a powerful editor for use on the expanded ZX81. It is intended for use by the serious BASIC programmer and offers several useful and time saving features most helpful during all stages of program development. The facilities provided are as follows: ALTER, BYTES, COPY, DELETE, FIND, HELP, INSERT, KEEP, MOVE, RENUMBER AND VERIFY. The Spectrum Toolkit contains most of the features above plus autoline numberer and append, and will run in the 16K and 48K spectrum.

Both at only £6.95



4K GRAPHICS ROM £24.95

The DK Graphic module is our latest ZX 81 accessory. This module unlike most other accessories fits neatly inside your computer under the keyboard. The module comes ready built, fully tested and complete with a 4K graphic ROM. This will give you an unbelievable 448 extra pre-programmed graphics, your normal graphic set contains only 64. This means that you now have 512 graphics and with their inverse 1024. This now turns the 81 into a very powerful computer with a graphic set rarely found on larger more expensive machines. In the ROM are lower case letters, bombs, bullets, rockets, tanks, a complete set of invaders graphics and that only accounts for about 50 of them, there are still about 400 left (that may give you an idea as to the scope of the new ROM). However, the module does not finish there, it also has a spare holder on the board which will accept a further 4K of ROM/RAM. This holder can be fitted with a 1K/2K/RAM and can be used for user definable graphics so you can create your own custom character sets.

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ORDER TODAY FOR FAST DELIVERY

FLEXIBLE RIBBON CONNECTOR

If you have ever had whiteouts or system crashes this could be the answer. It stops the movement between the computer and the RAM expansion, it is supplied with a ribbon, 6 inches long, with a male connector at one end and a female at the other, at only **£10**

16/64 MEMORY FOR ZX 81

The above illustration shows the casing for the 16K or massive 64K.

UM MEMORY

ansion £22.95

Dynamic Ram Chips. We use the dynamic as they are much denser than upy less space. They are also much cheaper than the equivalent product m. The Ram is manufactured with high quality materials, and uses high ams. It is supplied ready-built and only needs to be plugged into the rear of the components are fitted into holders. This massive add-on memory u fully assembled and tested is the cheapest 16K memory available anymemory from 16384 to 32768. (Same as the Sinclair memory.)

16K (UNCASED) £19.95

ansion £52.95

mation on the 16K also applies to the 64K Memory Expansion, but the e 64K giving nearly FOUR times the memory. This advanced model has ory. In addition, the block from 8K to 16K can be switched out to enable d-ons. The graphics ROM is to be used in this area. Position in Memory: ock From 8192-16384 is switchable.

64K (UNCASED) £49.95

y Expansion £35.00

trum to 48K of user Ram. The Spectrum memory expansion is simple to fit, nside the case, and then only requires plugging in. Full fitting instructions e only tool you will need is a screwdriver and just two minutes of your quires no electronic skills. Position in memory from 32768 to 65536. (The pgrade to 48K).

Please state type of machine, which Rom memory size, quantity and place when ordering

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Please send me . . . . . @ £. . . . . .

Please send me . . . . . @ £. . . . . .

Please add on £1.25 for P/P

In enclose cheque/P.O. payable to DK Tronics total £ . . . . . .

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(continued from page 85)

incorrect option is chosen, repeat the prompt, or skip the routine being called. A squeak will sound each time a menu option is chosen and valid entry made. In the Typewriter mode a key tap will sound with each key press.

To load the program Enter the Basic program and Save it by Goto 9900; this will auto-run the program when complete. Stop the tape at the second Start tape prompt and Verify the Basic before Newing it.

Your favourite machine-code loader, Clear 29665 and enter the machine code. Save this immediately after the Basic program using

SAVE "spc."CODE 29666,3102

and Verify.

Rewind to the start of the Basic program and Load "type". This will then load the machine code and auto-run. The first thing to appear on the screen will be the main menu.

If any section of the program fails to run then, using the list of routines and addresses, you should be able to check the machine code. I have purposely kept some of the program in Basic so that you may follow it more easily. It would be a simple task to convert all of option 1 and option 6 to machine code.

The routine starting at 29666 shows how to clear the Input lines 23 and 24 and which channel to open so that printing can be displayed on these lines. The Basic input Inkey$ can be replaced by a call to the ROM routine to clear the input lines, and the Basic

PRINT # x;"********"

can be replaced by Open Channel and Print String ROM calls. The rest of option 1 is then a straightforward case of checking which keys are being pressed by Peeking the variable Last Key at address 23560 and making the necessary jumps, and calls. For example, line 230:

```
      LD A, (23560)
      CP "n"
      JR NZ,NEXT
      CALL 31038
      JR LINE 50
NEXT  CP "m"
      RET Z
      JR LINE 60
```

The only time a Ret to Basic would be made is when the Menu option is chosen, so line 1000 would become;

1000 RANDOMIZE USR 'START ADDRESS' : GO TO m

and lines 50 to 780 and 8000 to 8040 could then be deleted. This would also have the benefit of making the Break key inoperable in the typewriter mode which can be annoying if Caps Shift and Space are pressed by mistake.

The machine-code dump.

```
29666  42 134 92  34 159 116
29672  42 136 92  34 161 116
29678  33 255 115 205
29684  197 205 163 116 193 205
29690  205 3   92  254 10  48
29696  29  119 214 48  56  205
29702  214 10  48  122 197 229
29708  62  255 205 1   225 205
29714  229 126 215 225 193 35
29720  4   120 254 1   32  213
29726  5   48  99  43  126 214
29732  48  58  159 116 5   48
29738  54  43  126 214 48  135
29744  74  135 135 129 79  62
29750  159 116 229 50  159 116
29756  5   48  34  43  126 214
29762  48  40  254 1   32  213
29768  4   14  100 24  13  254
29774  12  32  51  58  158 116
29780  214 56  48  44  14  200
29786  58  158 116 129 58  158
29792  116 58  158 116 50  41
29798  123 58  226 117 205 176
29804  123 6   32  116 16  253
29810  6   2   205 63  14  42
29816  159 116 34  124 92  42
29822  161 116 34  130 92  201
29828  205 106 123 254 119 116
29834  62  253 205 1   22  175
29840  215 175 215 175 215 205
29846  119 116 195 226 115 48
29852  48  40  0   205 63  14
29858  23  110 253 203 1   110
29864  40  253 203 1   110 40
29870  201 205 190 123 205 163
29876  116 58  5   92  214 49
29882  16  243 33  255 92  6
29888  46  237 6   24  205 66
29894  14  205 176 123 201 6
29900  205 174 118 62  4   50
29906  205 116 205 176 116 205
29912  225 126 201 205 43  119
29918  62  255 50  205 116 205
29924  178 116 201 205 111 120
29930  62  3   50  205 116 205
29936  178 116 201 205 13  121
29942  62  6   50  205 116 205
29948  178 116 201 205 111 121
29954  205 169 116 205 121 101
29960  50  0   92  254 1   32
29966  205 234 126 24  239 205
29972  163 116 205 201 205 201
29978  205 65  127 42  226 117
29984  50  226 117 119 58  4
29990  228 117 62  9   205 1
29996  22  54  62  215 58  5
30002  215 62  19  215 62  21
30008  215 58  5   215 205 117
30014  215 58  189 117 60  50
30020  185 117 58  226 117 125
30026  50  226 117 43  22  62
30032  2   205 1   22  62  22
30038  215 59  183 117 115 58
30044  227 117 215 62  143 215
30050  205 234 126 58  227 117
30056  50  254 19  40  8   50
30062  227 117 58  226 117 24
30068  212 205 113 121 205 175
30074  115 201 175 50  183 117
30080  17  24  120 117 41   41
30086  225 117 113 41  41  41
30092  41  41  41  41  41  41
30098  205 1   22  62  22  215
30104  62  15  215 62  22  215
30110  58  225 117 215 205 65
30116  127 62  22  215 62  21
30122  215 62  19  215 68  225
30128  117 215 205 113 121 201
30134  42  8   9   32  32  32
30140  32  32  32  32  32  32
30146  32  32  68  69  32  32
30152  32  78  111 46  68  68
30158  32  85  85  32  32  32
30164  117 1   23  0   205 60
30170  62  11  50  205 117 62
30176  201 32  0   18  232 120
30182  1   0   0   0   0   0
30188  16  6   143 143 143 143
30194  143 143 16  32  232 120
30200  205 197 121 62  2   205
30206  1   0   0   0   197 205
30212  233 117 60  50  233 117
30218  58  235 117 60  50  235
30224  117 17  230 117 1   18
30230  0   205 50  32  193 16
30236  229 175 50  233 117 62
30242  18  50  235 117 24  101
30248  0   0   0   0   0   0
30254  69  67  32  120 56  28
30260  9   11  32  98  99  100
30266  101 102 32  10  102  62
30272  80  69  67  84  62  65
30278  77  32  67  72  83  22  10  5
30284  32  69  32  61  32  32
30290  32  29  7   25  69  85
30296  32  77  79  68  69  22
30302  1   27  27  61  14  0
30308  66  22  32  27  96  61
30314  32  54  32  24  47  0
30320  32  0   0   0   0   0
30326  4   200 100 91  32  49
30332  54  22  8   101 101 21
30338  32  32  32  32  22  8  20
30344  10  62  32  32  32  20
30350  2   205 1   22  17  48
30356  118 110 40  205 50  0
30362  32  201 22  11  8   0
30368  65  59  32  52  69  69
30374  65  65  59  69  32  0
30380  32  67  62  2   205 1
30386  22  17  118 118 118 118
30392  0   205 60  32  205 101
30398  120 205 60  32  205 101
30404  79  78  84  73  78  85
30410  69  69  32  32  32  105
30416  105 108 32  114 101 115
30422  116 32  114 116 32  97
30428  116 32  77  69  78  85
30434  62  2   205 1   22  17
30440  118 110 40  205 50  0
30446  60  32  205 101 120 201
30452  32  32  80  65  21
30458  69  32  78  111 46  32
30464  116 111 32  99  101 32
30470  69  68  65  83  69  68
30476  32  68  69  32  32  32
30482  32  33  8   65  78  89
30488  32  32  32  32  32  32
30494  32  75  69  69  32  78
30500  79  32  32  32  69  78
30506  65  62  2   205 1   22
30512  1   244 118 1   56  0
30518  205 60  32  205 101 120
30524  201 28  15  7   30  65
30530  71  68  32  78  79  49
30536  32  32  32  69  32  65
30542  62  205 51  121 121
30548  205 107 121 62  3   205
30554  1   62  17  61  119 60
30560  0   205 60  32  62  22
30566  22  215 62  15  215 62
30572  16  215 58  231 183 198
30578  48  215 58  231 62  0
30584  34  78  54  76  79  32
30590  111 102 32  30  65  71
30596  71  68  32  78  79  49
30602  32  67  104 114 115 45
30608  32  67  65  85  41  32
30614  63  62  2   205 1   22
30620  117 215 3   119 1   56
30626  205 60  32  201 22  11
30632  3   215 62  54  60  60
30638  32  111 102 32  80  68
30644  71  69  33  32  116 111
30650  32  68  69  101 76  79
30656  65  68  69  68  6   34
30662  65  68  32  68  65  24
30668  65  32  88  36  40  41
30674  65  65  65  65  65  177
30680  156 119 1   44  0   205
30686  205 60  201 22  15  59
30692  85  119 105 116 99  104
30698  32  111 110  116 116 97
30704  112 101 32  32  32  32
30710  114 101 115 115 32  69
30716  76  68  32  32  32  80
30722  205 1   22  17  225 119
30728  1   31  62  205 60  32
30734  201 28  17  7   79  65
30740  107 32  32  32  32  69
30746  83  83  32  65  78  89
30752  32  32  32  32  69  32
30758  205 1   22  17  15  120
30764  1   0   0   205 22  11
30770  205 101 120 201 22  5
30776  1   69  76  83  69  32
30782  7   5   49  41  32  32
30788  78  79  32  77  85  76
30794  32  32  32  32  5   41
30800  32  39  78  69  87  39
30806  22  8   32  51  32  32
30812  32  32  69  69  69  78
30818  79  32  32  42  32  176
30824  34  54  92  201  0   0
30830  0   0   22  2   205 1
30836  22  24  205 60  14  22
30842  54  120 1   47  0   205
30848  60  22  0   205 101 120
30854  201 22  0   14  77  69
30860  78  85  22  2   5   49
30866  41  32  84  84  65  62
30872  32  32  32  32  5   40
30878  32  83  84  79  80  22
30884  32  32  32  32  32  32
30890  32  68  65  83  69  32
30896  32  68  65  65  21  69
30902  9   22  32  32  32  32
30908  65  86  69  32  80  65
30914  71  69  83  22  10  5
30920  83  41  32  76  79  65
30926  68  32  80  65  71  69
30932  83  32  32  32  5   41
30938  32  67  32  65  78  71
30944  69  78  94  5   50  0
30950  70  65  67  69  22  80
30956  5   127 32  49  57  56
30962  50  32  83  116 117  97
30968  114 116 32  116 105  99
30974  104 111 100 106 115  22
30980  16  24  95  95  95  26
30986  205 107 121 95  5   205
30992  1   22  6   24  205  65
30998  14  17  155 120 24  151
31004  0   205 60  32  0   0
31010  0   0   0   0   0   0
31016  78  92  32  11  142  98
31022  205 205 61  127 121  58
31028  6   93  214 48  58  131
31034  123 135 135 135 135 135
31040  92  254 119 192 58  131
31046  123 60  254 5   32  7
31052  62  5   58  131 123 205
31058  89  125 201 1   54  0
31064  139 121 254 121 11  117
31070  93  112 127 97  126 115
31076  124 100 92  92  183 103
31082  125 42  54  92  34  176
31088  92  237 6   0   0   0
31094  92  201 0   205 60  127
31100  58  5   92  205 245 126
31106  254 13  32  4   205 141
31112  127 201 58  139 127 254
31118  43  40  41  33  245 126
31124  254 32  32  4   205 153
31130  127 201 58  139 127 254
31136  214 95  208 58  145 92
31142  205 135 50  145 92  205
31148  244 126 58  145 92  205
31154  199 205 145 214 48  58
31160  127 201 58  245 126 254
31166  12  32  4   205 245 126
31172  201 205 180 127 201 58
31178  139 92  254 1   200 58
31184  9   92  33  91  121 1
31190  16  0   205 177 254 177
31196  40  0   254 177 254 177
31202  24  191 58  5   92  254
31208  122 192 205 172 14  201
31214  58  148 122 50  125 122
31220  205 119 122 58  125 122
31226  32  245 58  125 122 205
31232  118 122 241 121 58  245
31238  205 89  123 201 205 112
31244  123 127 205 175 237 92
31250  75  139 127 17  15  0
31256  92  205 183 127 175 237
31262  92  205 182 127 175 240
31268  92  32  7   182 179 32
31274  249 42  179 127 92  34
31280  148 71  79  18  197 205
31286  0   44  193 121 254 1
31292  201 205 112 123 175 237
31298  82  175 237 92  167 32
31304  42  0   25  16  253 237
31310  82  0   25  16  253 201
31316  42  139 127 48  32  3
31322  46  42  0   3   3   3
31328  1   1   34  139 127 205
31334  61  128 54  32  58  145
31340  92  205 145 92  245 205
31346  205 68  197 201 205 112
31352  123 127 17  0   0   0
31358  17  42  0   25  16  253
31364  0   6   123 127 175 237
31370  34  18  123 1   8   42
31376  126 0   0   0   0   0
31382  35  16  247 201 120 6
31388  0   0   0   42  0   123
31394  237 175 42  0   0   123
31400  52  42  144 48  5   71
31406  0   42  43  42  251 24
31412  0   42  18  123 5   41
31418  35  126 254 32  123 6
31424  18  248 35  126 254 32
31430  42  0   123 126 254 32
31436  42  0   123 126 254 32
31442  18  0   13  40  247 35
31448  42  0   13  40  247 35
31454  126 254 32  126 254 32
31460  126 254 32  126 254 32
31466  229 15  0   123 229 229
31472  43  237 254 48  3   243
31478  126 254 32  32  2   225
31484  123 225 243 0   0   0
31490  225 225 201 0   0   0
31496  229 252 209 143 101 205
31502  123 229 175 237 92  17
31508  0   0   0   0   22  25
31514  15  253 237 92  35  13
31520  15  253 229 213 229 225
31526  237 92  46  2   46  3
31532  225 225 201 229 193 243
31538  15  209 42  11  123 25
```

31550	237	176	225	24	13	225
31556	209	43	229	9	237	184
31562	225	237	91	41	123	25
31568	58	41	123	54	32	43
31574	61	32	250	6	24	197
31580	6	23	205	0	14	193
31586	16	247	205	148	123	201
31592	205	80	127	205	112	123
31598	201	0	42	75	92	126
31604	254	216	40	3	35	24
31610	248	17	7	0	25	17
31616	156	3	6	1	25	16
31622	253	201	205	112	123	54
31628	32	43	27	122	179	32
31634	248	201	205	112	123	6
31640	22	14	42	126	50	245
31646	126	237	67	26	127	229
31652	197	205	244	126	193	225
31658	40	13	32	237	16	233
31664	33	40	0	17	15	0
31670	229	205	161	3	225	17
31676	1	0	167	237	82	32
31682	240	201	6	50	197	33
31688	0	1	17	1	0	229
31694	205	161	3	225	17	16
31700	0	167	237	82	32	240
31706	193	16	233	201	0	0
31712	0	0	0	0	0	0
31718	0	0	16	16	16	15
31724	0	16	0	0	20	20
31730	0	0	0	0	0	0
31736	0	40	124	40	124	40
31742	0	0	16	56	80	56
31748	20	120	16	0	0	100
31754	104	16	44	76	0	0
31760	32	80	32	84	72	52
31766	0	0	16	16	0	0
31772	0	0	0	0	8	16
31778	16	16	16	8	0	0
31784	32	16	16	16	16	32
31790	0	0	0	40	16	124
31796	16	40	0	0	0	16
31802	16	124	16	16	0	0
31808	0	0	0	0	8	8
31814	16	0	0	0	0	124
31820	0	0	0	0	0	0
31826	0	0	16	16	0	0
31832	0	4	8	16	32	64
31838	0	0	56	76	84	84
31844	100	56	0	0	40	16
31850	16	16	16	56	0	0
31856	56	68	8	16	32	124
31862	0	0	120	4	56	4
31868	4	120	0	0	64	72
31874	72	124	8	8	0	0
31880	124	64	120	4	4	120
31886	0	0	56	64	120	68
31892	68	56	0	0	124	4
31898	4	8	16	32	0	0
31904	56	68	56	68	68	56
31910	0	0	56	68	80	68
31916	4	56	0	0	0	16
31922	16	0	16	16	0	0
31928	0	16	16	0	16	16
31934	32	0	0	16	32	64
31940	32	16	0	0	0	8
31946	124	0	124	0	0	0
31952	0	16	8	4	8	16

31958	0	0	56	68	8	16
31964	0	16	0	0	56	76
31970	84	92	64	56	0	0
31976	56	68	68	124	68	68
31982	0	0	120	68	120	68
31988	68	120	0	0	56	68
31994	64	64	68	56	0	0
32000	120	68	68	68	68	120
32006	0	0	124	64	120	64
32012	64	124	0	0	124	64
32018	120	64	64	64	0	0
32024	56	68	64	92	68	56
32030	0	0	68	68	124	68
32036	68	68	0	0	56	16
32042	16	16	16	56	0	0
32048	28	8	8	8	72	48
32054	0	0	72	80	96	80
32060	72	68	0	0	64	64
32066	64	64	64	124	0	0
32072	68	108	84	68	68	68
32078	0	0	68	100	84	76
32084	68	68	0	0	56	68
32090	68	68	68	56	0	0
32096	120	68	68	120	64	64
32102	0	0	56	68	68	68
32108	84	56	4	0	120	68
32114	68	120	72	68	0	0
32120	56	64	56	4	68	56
32126	0	0	124	16	16	16
32132	16	16	0	0	68	68
32138	68	68	68	56	0	0
32144	68	68	68	68	40	16
32150	0	0	68	68	84	84
32156	108	40	0	0	68	40
32162	16	16	40	68	0	0
32168	68	40	16	16	16	16
32174	0	0	124	8	16	32
32180	64	124	0	0	48	32
32186	32	32	32	48	0	0
32192	0	64	32	16	8	4
32198	0	0	24	8	8	0
32204	8	24	0	0	16	56
32210	84	16	16	16	0	0
32216	0	0	0	0	0	0
32222	0	252	24	36	32	112
32228	32	32	124	0	0	56
32234	4	60	68	60	0	0
32240	64	120	68	68	68	120
32246	0	0	0	60	64	64
32252	64	60	0	0	4	60
32258	68	68	68	60	0	0
32264	0	56	68	120	64	56
32270	0	0	24	36	32	120
32276	32	32	0	0	0	56
32282	68	68	68	60	4	56
32288	64	120	68	68	68	68
32294	0	0	16	0	48	16
32300	16	56	0	0	16	0
32306	48	16	16	16	88	32
32312	64	64	72	112	72	88
32318	0	0	64	64	64	64
32324	68	56	0	0	0	40
32330	84	84	84	84	0	0
32336	0	120	68	68	68	68
32342	0	0	0	56	68	68
32348	68	56	0	0	0	120
32354	68	68	68	120	64	64
32360	0	60	68	68	68	60

32366	4	4	0	56	68	64
32372	64	64	0	0	0	56
32378	64	56	4	120	0	0
32384	32	120	32	32	36	24
32390	0	0	0	68	68	68
32396	68	60	0	0	0	68
32402	68	68	40	16	0	0
32408	0	84	84	84	84	40
32414	0	0	0	68	40	16
32420	40	68	0	0	0	68
32426	68	68	68	60	4	56
32432	0	124	8	16	32	124
32438	0	0	48	32	32	64
32444	32	32	48	0	16	16
32450	16	16	16	16	0	0
32456	24	8	8	4	8	8
32462	24	0	0	0	52	88
32468	0	0	0	0	112	136
32474	232	200	232	136	112	0
32480	0	58	8	92	214	48
32486	195	78	121	0	17	1
32492	0	33	50	0	205	181
32498	3	201	33	14	0	41
32504	41	41	237	91	54	92
32510	25	6	8	14	6	86
32516	123	61	32	2	203	34
32522	203	34	220	22	127	13
32528	32	248	35	16	236	201
32534	197	213	229	33	17	22
32540	45	175	125	7	7	133
32546	133	111	203	36	203	36
32552	203	36	62	175	148	103
32558	62	6	145	133	79	120
32564	132	71	205	229	34	225
32570	209	193	201	33	1	60
32576	34	54	92	201	33	224
32582	122	34	54	92	201	0
32588	0	0	0	0	58	145
32594	92	203	199	50	145	92
32600	175	58	140	127	7	7
32606	7	71	62	183	144	71
32612	22	8	58	139	127	61
32618	79	7	7	129	129	79
32624	30	6	213	197	205	229
32630	34	193	209	12	29	32
32636	245	5	21	32	229	42
32642	139	127	34	26	127	34
32648	23	123	201	17	22	42
32654	139	127	24	16	205	61
32660	122	58	245	126	119	48
32666	139	127	44	125	254	43
32672	32	11	46	1	36	124
32678	254	23	32	3	33	43
32684	22	34	139	127	205	234
32690	126	201	1	254	254	237
32696	120	254	254	192	42	139
32702	127	1	254	247	237	120
32708	254	239	32	6	45	32
32714	46	44	32	43	1	254
32720	239	237	120	254	251	32
32726	13	44	125	254	44	40
32732	4	254	43	32	24	45
32738	24	21	254	247	32	6
32744	37	32	14	36	32	11
32750	254	239	32	10	35	124
32756	254	23	32	1	37	34
32762	139	127	205	234	126	201

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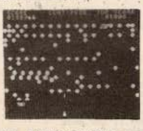

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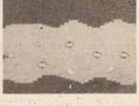

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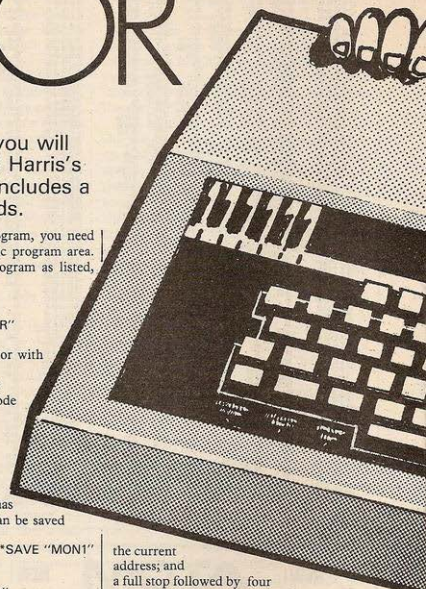
MONITOR



If you want to make the most of your BBC you will have to do battle with machine code. Richard Harris's monitor which tucks into just 2K of RAM yet includes a full disassembler should even up the odds.

WHY MIGHT you need a machine-code monitor? It could be that you want to investigate the machine-operating system, to see how programs and data are stored, or to test and change machine-code programs. Perhaps you wish to investigate screen layout, or even to recover corrupted Basic programs.

Whether you want to explore the workings of the BBC Micro or develop your own machine-code programs, this BBC monitor will fit most of the features of a good monitor into less than 2K, including a disassembler which — since it is written in machine code — runs a lot faster than some of the BBC disassemblers available commercially.

Six facilities

The monitor offers six facilities. It allows you to: display and change the contents of memory; display a block of memory; move a block of memory; run a section of machine code; disassemble code; and set the values of 6502 registers, run a subroutine and display the values of the registers on exit.

The published listing contains the assembly program which assembles the machine code for the monitor. It is not necessary, of course, to type in the comments and the preceding backslash.

Before running the program you must decide where you want the machine code to be assembled. Two of the most useful locations are below Page or above Himem. The version given here takes the first option and locates the monitor at 3600 — E10 in hex. To prevent it overwriting the assembly program, you need to move the start of the Basic program area. Once you have saved the program as listed, type in:

```
PAGE=&1500
NEW
LOAD "MONITOR"
RUN
```

You can now enter the monitor with

```
CALL &E10
```

If you prefer to store the monitor above Himem in Mode 7, set P% in line 30 to &6000 and type

```
HIMEM=&5FFF
LOAD "MONITOR"
RUN
CALL &6000
```

After the assembly program has been run the machine code can be saved as follows:

*SAVE "MON1" E10 1500 or *SAVE "MON1" 6000 6700

and loaded with

*LOAD "MON1"

Once in the monitor the screen should show

0000	FF 255	?
hex address	hex and decimal values	prompt

How to command

The monitor accepts the following commands: pressing the space bar increases the current address by one, and Return decreases it by one.

Entering two hex digits alters the value of the current address; and a full stop followed by four hexadecimal digits changes the current address. Entering the letter G displays an eight-by-eight block of data and addresses; entering R runs machine code from the current address; Z returns to Basic; and P enters the disassembler with the option of printer output. Press the space bar to continue disassembly and Return to leave it.

M moves a block of machine code. It expects three addresses in the form of four hex digits each — the Start and End address of the block to be moved, and the Start of the new block.

```
10REM MONITOR by R.W.Harris.
20FORM=1TO2
30P%=&E10                          :REM set base address of code
40data1=P%+955:data2=P%+1110:data3=P%+1265
50mess=P%+1420:Xmess=P%+1635:Pmess=P%+1670
60data4=P%+1675:sptab=P%+1745      :REM set base addresses of data
70[OPT0
80
90                          \ of byte value,as used by screen,etc
100                         \ binary is actual byte value
110                         \ msb is bits 4-7  lsb is bits 0-3
120.start LDA #0
130STA &00:STA &01:STA &82 \ initialize variables. set current
140LDA #100:STA &88         \ address (CA) to &0000
150LDA #10:STA &8A
160LDX #12
170.JSR &FFEE               \ clear screen
180.r6 JSR newlin           \ reentry for most routines.CR,LF
190.v6 JSR totalprint       \ print CA and value in hex and decimal
200.s JSR &FFE0             \ get ASCII value of key Press
210CMP #&2E
220BEQ addr                 \ if "." change CA
230CMP #32
240BEQ next                 \ if "space" increment CA
250CMP #13
260BEQ back                 \ if "return" decrement CA
270CMP #&5A
280BNE l
290RTS                      \ if "Z" return to BASIC
300.l CMP #&47
310BNE m
320JMP block                \ if "G" display block of hex values
330.m CMP #&52
340BNE n
350JMP (&0000)              \ if "R" run machine code from CA
360.n CMP#&4D
370BNE q1
380JMP move                 \ if "M" move block of data to new address
390.q1 CMP #&50
400BNE q2
410JMP diss                 \ if "P" goto dissassembler
420.q2 CMP #&53
430BNE o
440JMP subr                 \ if "S" goto sub-routine set-up
450.o JSR check             \ if none of above,check hex key Press
460CPX #0:BEQ a             \ if not get new key Press
470JSR upper                \ if hex convert to msb
480.JSR get                 \ get second hex key Press
490JSR lower                \ convert to lsb, combine with msb in A
500LDY #0
510STA (&00),Y              \ change value in CA
520.JMP v8                  \ to reentry
530.addr                    \ routine to change CA
540LDY #2
550.a4 JSR keysin           \ get and display 2 key Presses for high
560STA &007F,Y              \ byte,and 2 for low and store as CA
570DEY
580BNE a4
590BEQ ff
600.next                    \ routine to increment CA by 1
610INC &80
620BNE ff
630INC &81                  \ inc. high byte when low &FF ^ &00
640JMP ff
650DEC &80
660LDA &80
670CMP #&FF
680BNE ff
```

BBC

After the first two addresses have been entered, the monitor prints a greater-than symbol as a prompt character. Entering S allows a subroutine, starting at the current address, to be tested — so long as it ends in RTS. It requires the A,X and Y registers to be set and provides the option of setting the

(continued on page 94)

```
690DEC &81                  \ dec. high byte when low &00 ^ &FF
700JMP ff
710.get                     \ Gets hex kev Press
720JSR &FFE0
730JSR check                \ ? hex
740CPX #0
750BEQ get                  \ if not hex Get another
760RTS                      \ if hex return, value in A
770.uPper                   \ with "lower" converts hex to binary
780CMP #&3A
790BCC cc
800SBC #7                   \ subtract 7 if &A-&F
810.cc SEC:SBC #&30         \ subtract &30 0-9 and &A-&F
820ASL A:ASL A:ASL A:ASL A  \ rotate to msb
830STA &82                  \ and save
840RTS
850.lower
860CMP #&3A
870BCC bb
880SBC #7
890.bb SEC:SBC #&30         \ convert hex to lsb
900CLC:ADC &82              \ add to msb. return with value in A .
910RTS
920.block                   \ display 8x8 block of hex
930LDA #8
940STA &82
950LDY #0
960.cd LDX #8
970STX &83
980JSR neulin
990JSR addrPr               \ with address at start of each line
1000.bc LDA (&80).Y
1010JSR Print
1020LDY #2
1030JSR space               \ inc. CR
1040INC &80
1050BNE ab
1060INC &81
1070.ab DEC &83
1080BNE bc
1090DEC &82
1100BNE cd
1110JMP ff
1120.move                   \ routine to move block of data
1130LDY #6
1140JSR neulin
1150.9h JSR keysin          \ Get 12 key Presses. store as start and
1160STA &0002.Y             \ end addresses of block. and start of
1170DEY                     \ new block
1180BEQ de
1190CPY #4
1200BNE ef
1210LDA #&2C
1220JSR &FFEE               \ Prompt with ","
1230.ef CPY #2
1240BNE 9h
1250LDA #&3E
1260JSR &FFEE               \ Prompt with ">"
1270JMP 9h                  \ XXXX.YYYY>ZZZZ displayed
1280.de JSR escape          \ OK to Proceed?
1290INC &85
1300BNE tv
1310INC &86                 \ inc. end of block. else last byte missed
1320.tv LDA &83:STA &80
1330LDA &84:STA &81         \ start of new block = new CR
1340DEX                     \ X= 1 on exit of JSR escape
1350.td LDA (&87.X)         \ do move
1360STA (&83.X)
1370INC &83
1380BNE km
1390INC &84
1400.km INC &87
1410BNE hi
1420INC &88
1430.hi LDA &87
1440CMP &85
1450BNE td
1460LDA &88
1470CMP &86
1480BNE td
1490JMP ff
1500.addrPr                 \ Print CR in hex
1510LDA &81
1520JSR Print
1530LDA &80
1540JSR Print
1550LDY #3
1560JSR space:RTS           \ + 2 spaces
1570.check                  \ ? is value in A hex
1580LDX #0
1590CMP #&30
1600BCC e
1610CMP #&3A                \ ie ASCII 0-9
1620BCC f
1630CMP #&41
1640BCC e
1650CMP #&47                \ ie ASCII A-F
1660BCS e
1670.f LDX #1               \ if yes. X= 1. if no. X= 0
1680.e RTS
1690.totalPrint             \ Prints -
1700LDA #13
1710JSR &FFEE               \ CR
1720JSR addrPr              \ CR
1730LDA (&80).Y             \ hex value in CR
1740JSR Print
1750LDY #4
1760JSR space               \ 4 spaces
1770LDA (&80).Y
1780JSR dec                 \ decimal value in CR
1790LDY #4
1800JSR space
1810LDA #&3F
1820JSR &FFEE               \ "?" Prompt
1830RTS
1840.Print                  \ Print binary value in A as hex
1850TAX                     \ save value in X
1860AND #&F0                \ mask msb
1870LSR A:LSR A:LSR A:LSR A\ rotate to lsb
1880JSR Prout               \ Print
1890TXA                     \ restore value
1900AND #&F                 \ mask lsb
1910.JSR Prout              \ Print
1920RTS
1930.Prout                  \ converts binary in A
1940CMP #&A
1950BCC z
1960CLC:ADC #7
1970.z ADC #&30             \ to hex
1980.JSR &FFEE              \ and Prints
1990RTS
2000.space                  \ Prints spaces
2010LDA #32
2020.x JSR &FFEE
2030DEY                     \ number in Y on entry
2040BNE x
2050RTS
2060.dec                    \ Prints binary in A as decimal
2070LDX #2:STX &8C          \ flag for "0" or leading blank Printed
2080.kx LDY #&30            \ count number of 100's and 10's
2090.kq CMP &89.X           \ count number of 100's and 10's
2100BCC kz
2110INY
2120SBC &89.X               \ 100 or 10 subtracted from A. count in Y
2130BCS kq
2140.kz CPY #&30
2150BNE kw
2160CPX &8C                 \ Print "0" or blank
2170BNE kw                  \ if none
2180LDY #32
2190DEC &8C
2200.kw PHA                 \ else save remainder
2210TYA
2220JSR &FFEE               \ and Print count
```

(listing continued on page 93)

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(listing continued from page 91)

```
2230PLA                     \ restore remainder
2240DEX
2250BNE kx
2260ROC #$30                \ when units left convert to hex and print
2270.JSR &FFEE
2280RTS
2290.message9e              \ Prints "message9e"
2300LDR mess-1.Y            \ Y holds starting Point in "message9e data"
2310.JSR &FFEE              \ X holds length
2320DEY:DEX
2330BNE message9e
2340RTS
2350.YorN                   \ Gets either "Y" (yes)
2360.JSR &FFE0              \ or "N" (no) key Press
2370CMP #$59
2380BEQ s3
2390CMP #$4E
2400BNE YorN
2410LDX #0:RTS              \ if no, X= 0, if yes X= 1
2420.s3 LDX #1:RTS
2430.newlin                 \ does 2 CR/LF
2440.JSR &FFE7:JSR &FFE7:RTS
2450.keysin                 \ Gets and displays 2 hex key Presses
2460.JSR Get
2470.JSR &FFEE
2480.JSR upper
2490.JSR Get
2500.JSR &FFEE
2510.JSR lower              \ converts to binary, in A on exit
2520RTS
2530.diss                   \ dissassmbler -starts at CR
2540.JSR newlin
2550LDY #101
2560LDX #13
2570.JSR message9e          \ ? output to Printer
2580.JSR YorN
2590BEQ s4
2600LDY #190
2610LDX #7                  \ if yes initialize Printer
2620.JSR message9e          \ values Given for Microline 80
2630.s4 LDA &14             \ counter for lines of output
2640STA $83
2650.s5 JSR &FFE7
2660LDY #0
2670LDA (&80).Y             \ Get value in CR
2680LDX #$97
2690.s6 CMP data3.X         \ check if opcode
2700BEQ s7                  \ if is.branch
2710DEX
2720BNE s6                  \ if not -
2730.JSR addrPr             \ Print CR
2740LDA (&80).Y             \ and contents
2750.JSR Print
2760LDY #10
2770.JSR sPace              \ 10 sPaces
2780LDY #191
2790LDX #10
2800.JSR message9e          \ NOT OPCODE message9e
2810.s9 INC &80
2820BNE s8
2830INC &81                 \ increment CR
2840.s8 DEC $83
2850BNE s5                  \ repeat till required number of lines
2860.u1 JSR &FFE0           \ Get key Press
2870CMP #$20
2880BEQ s4                  \ if "sPace" continue dissassmblv
2890CMP #$0D
2900BNE u1                  \ if "return" exit to monitor
2910LDY #203
2920LDX #5
2930.JSR message9e          \ turning off Printer
2940.JMP rr
2950.s7 LDA data2.X         \ if value is opcode, X is Pointer to
2960STA &84                 \ Get Pointer to "name" in message data
2970LDA data1.X             \ Get Pointer to "address type" data
2980STA $85
2990TAX                     \ use this Pointer
3000LDA data4.X             \ to Get number of Bytes from
3010STA &86                 \ "address type" data
3020.JSR addrPr             \ Print CR
3030LDA (&80).Y
3040.JSR Print              \ and contents
3050LDX &86                 \ restore "number of bytes"
3060BEQ u2
3070.u3 INC &80
3080BNE u4
3090INC &81                 \ increment CR
3100.u4 LDA #32
3110.JSR &FFEE              \ Print sPace
3120LDA (&80).Y
3130STA $07.X               \ Get and Print and store value in new CR
3140STX &07
3150.JSR Print
3160LDX &87
3170DEX                     \ repeat for number of bytes
3180BNE u3
3190LDX &86
3200.u2 LDY sftab+1.X       \ Get number of sPaces from table
3210.JSR sPace              \ and Print to keep output aligned
3220LDX #3
3230LDY &84
3240.JSR message9e          \ Print opcode name
3250LDA #32
3260.JSR &FFEE              \ and sPace
3270LDY &85                 \ address type Pointer
3280BEQ u5                  \ branch if "relative"
3290INY                     \ skip "no. of bytes" data
3300.u6 LDA data4.Y         \ Get byte from "address type data"
3310BEQ u7
3320CMP #1
3330BEQ u7                  \ branch if 0 or 1
3340CMP #$FE
3350BNE u8                  \ if "FE" return for next opcode
3360LDX &85
3370BEQ u9
3380.JMP s9
3390.u9 JMP s8              \ avoiding inc. CR if was "relative"
3400.u7 TAX                 \ if data 0 or 1 then Print
3410LDA &80.X               \ high or low byte of address field
3420.JSR Print
3430INY
3440BNE u6
3450.u8 JSR &FFEE           \ if not 0,1,FE Print ASCII equiv
3460INY
3470BNE u6                  \ next byte of "address type data"
3480.u5 LDA &80             \ relative branching3 sums
3490TAX                     \ branch value in X and A
3500INC &80
3510BNE e1
3520INC &81                 \ increment CR
3530.e1 CLC
3540ROC &80
3550TAY &89
3560LDY &81                 \ Get high byte in Y
3570TXA                     \ restore branch value
3580CMP #2                  \ 7 branch +ve or -ve
3590BCS e3
3600DEY
3610.e2 BCC e3
3620INY                     \ inc. or dec. Y if over Page boundary
3630.e3 STY &80             \ and store as new high byte
3640LDY #7                  \ return to Print out as if
3650BNE u6                   absolute addressing
3660.s2 STX &85             \ save X
3670.JSR keysin             \ Get and Print 2 key Presses
3680LDX &85                 \ restore X
3690STA &85.X               \ save binary value for Y,X,A
3700DEY
3710DEY
3720BNE s1
3730.subr                   \ subroutine set-up
3740.JSR newlin
3750LDY #33
3760LDX #3
3770.s1 LDA XYmess-1.Y      \ Get data for message
3780BEQ s2                  \ branch if 0 (3 times) for input
3790.JSR &FFEE              \ else Print ASCII equiv
3800DEY
3810BNE s1
3820STY &84                 \ set flag to 0
3830.JSR YorN               \ "yes or no" to set status request
3840BEQ s3
3850.JSR newlin
3860LDY #4
3870STY &84                 \ if yes reset flag
3880.s4 LDA Pmess-1.Y       \ Print "P="
3890.JSR &FFEE
3900DEY
3910BNE s4
3920.JSR keysin             \ Get key Press input
3930STA $89                 \ save binary
3940.s3 LDA #$4C
3950STA $7F                 \ Put JMP opcode before CR
3960.JSR escape             \ OK to Proceed?
3970.JSR newlin
3980LDX &88
3990LDY &87                 \ set X,Y with stored values
4000LDA &86
4010PHA                     \ save value for A
4020LDA &84
4030BEQ s5                  \ if flag set
4040LDA $89                 \ Get value for P
4050PHA
4060JMP                     \ set P via stack
4070.s5 PLA                 \ set A without affecting status P
4080.JSR $007F              \ do subroutine at CR
4090STX $88
4100STY $87
4110STA $86
4120PHP
4130PLA
4140STA $89                 \ save X,Y,A,P on return
4150LDY #39
4160LDX #3
4170.s6 LDA XYmess-1.Y      \ Print message -branch if data = 0
4180BEQ s7
4190.JSR &FFEE
4200DEY
4210CPY #15
4220BNE s6
4230LDY #3
4240.s8 LDA Pmess-1.Y       Print "P=" message
4250.JSR &FFEE
4260DEY
4270BNE s8
4280LDA $89
4290.JSR Print              \ Print hex of P
4300.JMP rr                 \ return to monitor
4310.s7 LDA $85.X
4320STX $85
4330.JSR Print              \ Get and Print X,Y,A in turn
4340LDX $85
4350DEX
4360DEY
4370BNE s6
4380.escape                 \ OK to Proceed routine
4390.JSR newlin
4400LDY #210:LDX #7
4410.JSR message9e          \ Print message
4420.JSR YorN               \ Get yes or no response
4430BNE u4                  \ if no return to monitor
4440PLA:PLA                 \ correcting stack for 1 subroutine
4450.JMP rr
4460.u4 RTS                 \ if yes, Proceed
4470:NEXT M
4480                        REM
4490                        REM DATA STATEMENTS
4500                        REM data4= "address type" data
                                 data1= Pointer to data4
4510                        REM data2= Pointer to message data
4520                        REM data3= opcode search table
4530Pmess=" =P "
4540
4550XYmess="?N/Y sutatS teS  "+CHR$(0)+" =R  "+CHR$(0)+" =Y
     "+CHR$(0)+" =X"
4560
4570MESS$="DNACDALSAKRBLPBIMBQEBENBCVBSVBCCBSCBTIBVPCKPCPMCDLCILCC
    LCVLCROEYEDMEDCEDYNICNIKNIPMJRSJRDLXDLYDLRSLPDNRRDRHPRLPMPPLP
    RDRLORBTRITRCBB"
4580MESS$=MESS$+"KTSYTSRTSCESIESDESXRTRKTYRTRYTRKSTSKT ?N/Y RETNIRP
    EDOCPO TON"
4590FORJ=1TO12:READS
```

(listing continued on next page)

(continued from page 91)

status register. On return from the subroutine it displays the contents of the registers. This is very useful in exploring *FX and other operating system calls.

The program listing is well annotated which should make it relatively easy to follow for those who want to understand exactly how it functions. One improvement they could try is to insert a routine into the disassembler to print out the ASCII characters for each bytes.

To put the monitor through its paces, you might like to try the following procedures. Enter the monitor with Call &E10 and then change the current address to &E10 by pressing the full stop key and typing 0E10.

Viewing versions

Remember that the monitor only accepts four-figure hexadecimal entries. If you now press P you will see the same disassembled version of the monitor that you keyed in earlier.

Press M and then enter 0E10, 1500 and 4000. This will copy the monitor to &4000 and if you press R it will call itself.

Finally you could try the facility for testing a subroutine by calling OSASCI. This is the operating system routine which writes a character from the Accumulator to the screen.

First change the current address to &FFE3 and press S. Set the X and Y registers to zero and the A register to 72, the ASCII code in hex for lower-case R. When run OSASCI will print a lower-case letter R to the screen in front of a display of the contents of the X register.

(listing continued from previous page)

```
4500MESS$=MESS$+CHR$(3):NEXT
4510DATA2,30,1,66,1,27,1,65,1,27,1,3
4520MESS$=MESS$+"7N/Y K0"
4530*mess*MESS$
4540
4550FORJX=1TO3:READS%
4560*ftab7JX=S%:NEXT
4570DATA10,7,4
4580
4590FORJX=0TO68:READS%
4700*dta47JX=S%:NEXT
4710DATA1,1,&23,&26,0,&FE,2,&26,0,1,&FE,2,&26,0,1,&2C,&58,&FE,2,&26,0,1,&2C,&59
,&FE,1,&26,0,&FE,1,&26,0,&2C,&58
4720DATA&FE,1,&26,0,&2C,&59,&FE,1,&28,&26,0,&29,&2C,&59,&FE,1,&28,&26,0,&2C,&58
,&29,&FE,2,&28,&26,0,1,&29,&FE,0,&41,&FE,0,&FE
4730
4740FORJX=1TO151:READS%
4750*dta17JX=S%:NEXT
4760DATA67,49,25,25,67,1,64,6,6,0,41,29,29,67,18,11,11,6,49,25,25,25,67,1,64,6,
6,6,0,41,29,29,67,18,11,11
4770DATA67,49,25,25,67,1,64,6,6,6,0,41,29,29,67,18,11,11,67,49,25,25,67,1,64,57
,6,6,0,41,29,29,67,18,11,11,49,25,25,25,67,67,6,6,6,0,41,29,29,35,67,18,67,11
4780DATA1,49,1,25,25,25,67,1,67,6,6,6,0,41,29,29,35,67,18,67,11,11,18,1,49,25,2
5,25,67,1,67,6,6,6,0,41,29,29,67,18,11,11,1,49,25,25,25,67,1,67,6,6,6,0,41,29,29
,67,18,11,11
4790
4800FORJX=1TO151:READS%
4810*dta27JX=S%:NEXT
4820DATA12,105,105,9,114,105,9,105,9,15,105,105,9,57,105,105,9,87,3,39,3,123,11
7,3,123,39,3,123,18,3,3,123,144,3,3
4830DATA123,123,63,63,99,108,63,99,84,63,99,27,63,63,99,54,63,63,99,126,6,6,120
,111,6,120,84,6,120,30,6,6,120,147,6,6,120
4840DATA141,138,141,135,66,156,138,141,135,33,141,138,141,135,162,141,168,141,9
6,90,93,96,90,93,159,90,153,96,90,93,36,90,96,90,93,60,90,165,96,90,93
4850DATA42,48,42,48,72,75,48,69,42,48,72,24,48,48,72,51,48,48,72,45,132,45,132,
78,81,132,102,45,132,78,21,132,132,78,150,132,132,78
4860
4870FORJX=1TO151:READS%
4880*dta37JX=S%:NEXT
4890DATA0,1,5,6,8,9,&A,&D,&E,&10,&11,&15,&16,&18,&19,&1D,&1E,&20,&21,&24,&25,&2
6,&28,&29,&2A,&2C,&2D,&2E,&30,&31,&35,&36,&38,&39,&3D,&3E
4900DATA&40,&41,&45,&46,&48,&49,&4A,&4C,&4D,&4E,&50,&51,&55,&56,&58,&59,&5D,&5E
,&60,&61,&65,&66,&68,&69,&6A,&6C,&6D,&6E,&70,&71,&75,&76,&78,&79,&7D,&7E
4910DATA&81,&84,&85,&86,&88,&8A,&8C,&8D,&8E,&90,&91,&94,&95,&96,&98,&99,&9A,&9D
,&A0,&A1,&A2,&A4,&A5,&A6,&A8,&A9,&AA,&AC,&AD,&AE
4920DATA&B0,&B1,&B4,&B5,&B6,&B8,&B9,&BA,&BC,&BD,&BE,&C0,&C1,&C4,&C5,&C6,&C8,&C9
,&CA,&CC,&CD,&CE,&D0,&D1,&D5,&D6,&D8,&D9,&DD,&DE
4930DATA&E0,&E1,&E4,&E5,&E6,&E8,&E9,&EA,&EC,&ED,&EE,&F0,&F1,&F5,&F6,&F8,&F9,&FD
,&FE
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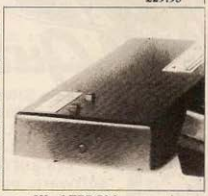

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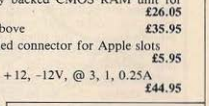

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BBC ASSEMBLER

You can always tell a good assembler by its range of pseudo-op codes. Chris Melville looks at the BBC's resident assembler.

IN MORE ADVANCED assemblers we expect to see a wide range of pseudo-ops that could be used in our programs at assembly time. Figure 1 gives examples.

One should remember that all pseudo-ops are merely instructions to the assembler and in no way affect the machine code produced when it is eventually run.

The BBC assembler is part and parcel of the BBC Basic interpreter. As such it has access to the expression evaluator used in BBC Basic which means that almost any sensible expression that is valid in BBC Basic, providing it has a numerical result can be used inside an assembly language program. This in turn means that a lot of the funcations and variables available in Basic can be used, including your own as defined by Def Fn, as long as the results they produce are compatible with where they are used. For example, all of the following would assemble as the same thing:

```
LDA# SIN(RAD(90))* 30 + 5
LDA# 35
LDA# &23
LDA# ASC"# "
LDA# A%
```

has the ASCII value 35, A% has previously been assigned as 35 and ampersand indicates hexadecimal value in BBC Basic.

Any expression resulting in a floating point result will merely be truncated to the next lowest integer.

The Basic interpreter is suspended and the assembler brought in at any time by using the Basic statement [. Similarly the assembler returns control immediately to the interpreter on encountering]. Upon leaving the assembler, executing some Basic and then returning again to assembler, all assembly pointers such as the location pointer remain unchanged. This facility allows Basic and assembly language to be freely mixed and we will shortly see that mixing the odd Basic statement with the assembly language can provide a simple way of implementing all of the properties/pseudo-ops given in figure 1.

It is important to remember that when the assembler is called by [, all that happens is the conversion of the mnemonics into absolute binary machine code which is sequentially stored. The routines will not actually be executed until you call them using the Basic statements Call and Usr. This is shown simply in figure 2.

The Dim statement in BBC Basic will look for a continuous block of free memory, the amount depending on its argument, and return the address of the start of this block into a variable. To reserve a block of 200 bytes and assign the starting address to the variable start% use Dim start% 199.

This should be used, before entering the assembler, to bag some memory space for your assembled program unless you want it to be placed at some particular address onwards, which is fine if you are not bothered about it working across the Tube. So if your program is n bytes long — or less — then you need:

```
DIM space% n : P% = space%
```

This form of the Dim statement is not to be confused with Dim space%(n) which would declare an integer array called space%,n elements long.

The BBC assembler supports the use of labels in assembly language programs and these are handled as if they were Basic variables. Therefore they must start with a letter and not a reserved word. When labels are first defined they must be preceded with a full stop, and finish with RTS. When they are referred to, the full stop can be omitted, and needless to say they should not be multiply defined.

Since the assembler starts off at the beginning of an assembly language program and proceeds sequentially through it, problems arise when program segments include instructions referring to a label ahead before it is defined to the assembler.

This problem is overcome by making the assembler pass through the program twice, firstly taking note of all the labels and their values, which are stored in the Basic variable space in RAM and performing crude assembly of the mnemonics, translating the op-code and addressing mode, but not the address unless it is known, and substituting in any addresses it failed to find first time. If the assembly listing were examined in between these two passes, it would be seen that any instructions where forward reference occurred would have their address fields pointing to themselves. This two-pass process does not occur automatically on the BBC computer. It is necessary to force it to happen by enclosing the whole assembly language section in a For-To-Next loop which will be done twice. Of course this is unnecessary when there are no forward references in the program.

The choice of value of control variable in the loop is determined by what you want the assembler to output and how you want it to react to the presence of errors caused by forward referencing. This is explained now as we deal with the BBC assembler's only pseudo-op, OPT.

The usual state of affairs is that we require different assembler output on each pass of the assembler, and the most common occurs like this. On Pass 1, assembler errors are suppressed so that the process is not interrupted should forward references be present. There will be no assembly listing since the process will not be complete. On Pass 2, assembler errors are given — there are no unresolved forward references for this pass so we wish to be informed if any real errors are present.

We either see no listing at all or a full assembly listing of locations, hex code, mnemonics and labels.

We control this by using the "OPT n" pseudo-op straight after the opening square bracket. The possibilities are OPT 0 for error supression and no listing, OPT 1 for error supression and a listing, OPT 2 for error reporting and no listing OPT 3 for error reporting and a listing. This is incorporated into the For-Next loop of the last section.

```
For pass% = a To b step b-a
[     opt pass%
                ]
Next pass%
```

The "a" is the OPT value required in the first pass and b is the one for the second. Normally, a=0, b=2 or 3. The OPT pseudo-op obviously generates no machine code of its own.

The resident integer variable P% is the location pointer for the BBC assembler, that

(continued on next page)

ADC	add with carry	INY	inc. y
AND	logical and	JMP	jump
ASL	arthmetic shift left	JSR	call subroutine
BBC	branch if carry clear	LDA	load accumulator
BCS	branch if carry set	LDX	load x
BEQ	branch if equal	LDY	load y
BIT	test bit	LSR	logical shift right
BMI	branch if minus	NOP	no-operation
BNE	b. not equal	ORA	logical or
BPL	b. if plus	PHA	push accumulator
BRK	break	PHP	push processor status
BVC	b. overflow clear	PLA	pull into accumulator
BVS	b. b. overflow set	PLP	pull processor status
CLC	clear carry	ROL	rotate left
CLD	clear decimal mode	ROR	rotate right
CLI	clear interrupt disable	RTI	return from interrupt
CLV	clear overflow	RTS	return from subroutine
CMP	compare to accumulator	SBC	subtract with carry
		SEC	set carry
CPX	compare to x	SED	set decimal
CPY	compare to y	SEI	set interrupt disable
DEC	decrement memory	STA	store accumulator
DEX	decrement x	STX	store x
DEY	decrement y	STY	store y
EOR	exclusive or	TAX	transfer a to x
INC	increment memory	TAY	transfer a to y
INX	inc. x	TSX	transfer sp to x

Table 1. The 6502 instruction set.

TXA transfer x to a
TXS transfer x to sp
TYA transfer y to acc

The 6502 registers:
accumulator (A) 8 bits
x,y index registers (x,y) 8 bits
processor status register nvbdizc 8 bits
program counter 16 bits
stack pointer 8 bits

6502 addressing modes

Name	Example
Immediate	LDX # 23
Zero page	LDY &32
Absolute	JMP &FFF3
Accumulator	ASL A
Relative	BEQ &23E3
Indirect	LDA (&2345)
Implied	PHA
Zero page x	STA 55,x
Absolute x	JMP &FF00,x
Pre-indexed direct	LDA (9,x)
Post indexed direct	LDA (34),y
Zero page with y index	STA 22,y

(continued from previous page)
is, it always holds the value of the address where the next encountered assembly instruction will be assembled to. Thus if we wanted a particular program to be assembled starting at location &A00 we would put, immediately after the For-To loop start; P%=&A00.

Alternatively, with the memory allocating system as previously described;

```
DIM space% PROGRAMSIZE
P% = space%
```

If one wants to leave a few spare bytes in memory in the middle of the machine code program, say for workspace or constant storage, then another alternative to the Dim method described earlier would be to leave the assembler and increment P% by the number of bytes you want. You could also use the byte indirection operators to initialise this memory, e.g., ?P%=. Then record the starting address of for example spare bytes, room=P% before you increment P%. Re-enter assembler and continue, using instructions such as LDA room to access your bytes. Issue I Basic/assembler does not allow the assembly of numerical constants straight into memory. To place constants in memory one should therefore use one of the methods already described. Issue II Basic/assembler does have the necessary pseudo-ops. These are EQUB, EQUW, EQUS and EQUD.

These all take a single argument and put its value into the assembly code.

```
.message EQUS "hello"
```

would store at ASCII code of "h" at message, "e" at message +1 and so on.

Unfortunately, there is no easy way that macros can be implemented with the assembler contained in Issue I Basic. However, the EQUS pseudo-op present in the Issue II Basic assembler can be used along with the Def Fn statement to implement macros of sorts.

A subroutine call to location &FFF4 in the operating system is known as an OSByte call. This call uses the processors X,Y,Acc registers to pass information to the operating system; Acc defines the operation to be carried out such as clear input buffer or alter flash rate or anything else that can be done as an FX call. X,Y contain the parameters. We could set up a macro which would take these three quantities as parameters, load them into the respective processor registers and call the OSByte routine. The macro itself would be defined in Basic as a function:

```
DEF FNOSBYTE (A,X,Y)
IF A>127 THEN [ OPT pass% : LDY # Y]
[OPT pass%: LDX # X : LDA# A: JSR &FFF4 :]
        (dummy null string result)
```

Only OSByte calls with numbers over 12 need a Y parameter. Then, when writing an assembly program if we wanted to do an OSByte call we would do the following:

```
EQUS FNOSBYTE (&87,5,5) reads the
  character at text (5,5)
EQUE FNOSBYTE (2,1,0) gets characters
  from RS423
```

Whenever the assembler encounters the above syntax the result will be the normal OSByte code sequence inserted into the assembly process, no string is actually inserted anywhere as the EQUS is fed with a null string by the function FNOSByte which also manages to do a little assembling before it gives this null result.

The ability to freely alternate between Basic and assembler makes conditional assembly a simple problem to solve. First leave Basic, use the control structures of Basic to examine the condition — use If-Then-Else, On-Goto/Gosub, and assemble the appropriate sections of code upon the result. If you want the assembler to choose between keyboard or joystick input in pseudo-Basic:

```
assemble ..... ] ; IF joystickconnected
THEN PROCassemblejoystickcode ELSE
PROCassemblekeycode [ :.....assembler
```

The two given procedures do exactly what they say.

Repeated assembly is easy to achieve because of the easy interaction between the assembler and the Basic interpreter proper. There are two kinds of loops into which we can put the assembly language that we want copying.

Deterministic loops continue copying out the instructions until some condition is satisfied. We would use a repeat-until loop in the Basic part:

```
assemble] : REPEAT
    [ : (insert whatever is to be repeated here.
    it may involve the control variable, and
    there should be an OPT to control
    assembler output.) : ]
    There could be some Basic instructions
    here which would effect the loop control
    condition.
    UNTIL condition
    [: OPT pass% :.....assemble.
```

Non-deterministic loops repeat the assembly mnemonics a fixed number of times. For this we would use a For-To loop:

```
...(assembler)] : FOR I% = startno. TO finishno.
    [ : OPT pass% : ..... assembly
    instructions, could involve the control
    variable I% if required. .....:]
    NEXT I%
    [ : OPT pass% :.....(back to assembler)
```

Diagram summarising assembly process

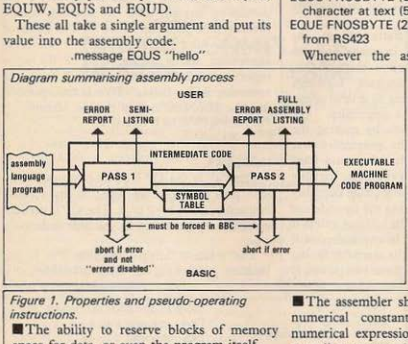

Figure 2. Calling routines.

```
10 PRINT "hello"
20 PRINT "now
   entering assembler"
30 DIM P% 100
40 enter assembler
50 .start PHA:TAX:
   CMP# &33 (more
   arbitrary assembly
   language)
100 RTS:
110 PRINT "back in
   Basic"
120 CALL start
```

Figure 1. Properties and pseudo-operating instructions.

■ The ability to reserve blocks of memory space for data, or even the program itself.

■ The allowing of symbolic labels and a multi-pass system, usually two occasionally three. This includes the automatic calculation of relative jumps.

■ The ability to reference the location pointer, a pointer to the next byte that will store machine code produced by the assembler, so that it is possible to use relative jumps in programs. For instance:

```
JMP . -5
```

allows you to jump back to the instruction five bytes further back in memory. The full point indicates the value of the location pointer.

The location in memory where the next instruction is to be assembled can be specified by a statement such as:

```
=3200
```

■ User output — an assembly listing should be given, in both hex and mnemonics, errors should be reported and — preferably — there should be a symbol table output.

■ The assembler should be able to assemble numerical constants, or the result of a numerical expression, directly into memory, as well as mnemonics. For example:

```
label    32
label+1 19-5
```

should result in the constant 32 stored in the location given by label, and 14 stored in label+1

■ It should also be able to evaluate simple numerical expressions elsewhere, so that

```
LDA# 7*2-2/2
```

would assemble as

```
LDA# 13
```

■ There should be a facility for the creation and use of macros. A macro is a set of instructions that does a particular job, similar to a subroutine in that respect, and given a specific name. Then, whenever the assembler comes across that name in a program it substitutes it with the set of instructions to which the name refers. Some assemblers allow macros to use parameter-passing also.

■ Conditional assembly — this facility allows the assembler to choose one of several program segments to assemble depending on the result of some specified test which is specified by the programmer and carried out at assembly time.

■ Repeated assembly — if a group of assembly language instructions are listed over and over in a program then it would be handy if it was necessary to write them only once and tell the assembler how many times to repeat them in a row. This is repeated assembly, for example:

```
REPEAT 10
        LDA somevalue
ENDREPEAT  STA somewhere
```

This might tell the assembler to write out the two instructions 10 times in a row and then assemble them. In some cases it might be possible for the values somevalue and somewhere to change each time the instruction pair is copied. Also, it may be possible for the number of copies to depend upon some condition rather than a fixed number, the difference between a For-To loop and a Repeat-Until loop in Basic illustrates this.

■ The assembler should recognise all 6502 mnemonics and addressing modes. ■

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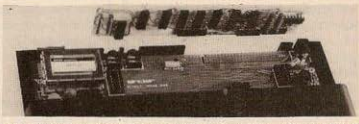

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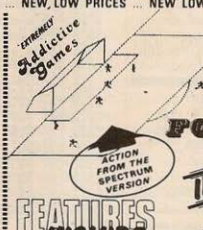

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Dear Sir,

I received a copy of your Football Manager, Spectrum 48K game a couple of weeks ago and felt I must just write and congratulate you on such an 'addictive game'.

I started on the beginners skill level with Ipswich Town in the Fourth Division. After having played six seasons I am now into the first division having won the F.A. Cup whilst in the second division. All of which took about nine hours of being glued to the screen.

Since reaching the first division I have increased my skill level and am now sixth in the table after ten seasons and about 15 hours!

The reason I am surprised that I have played this game more than any other in my library over the last two weeks, is because I don't really like watching football on television. I don't even support a team. The structure of your game is such that anyone can play it.

P. A. HACKMAN,
BURY ST. EDMUNDS

ORIGINALS CAN BE SEEN ON REQUEST

ONCE UPON a time when most people still thought that a microprocessor was some fancy kitchen gadget, breakfast was continually disturbed by the rhythmic chant of children trying their new French vocabulary for school that morning. When we acquired a ZX-81 we therefore set about using this so that our 'snap, crackle and pop' would not be disturbed.

The very limited memory of the basic 1K unit was a severe problem, but with care 20 words — each 12 characters long, in each of two languages, could be stored for knowledge testing. Two separate programs needed to be used. The Word-loader program dimensions three arrays and requests 20 consecutive word inputs in each language. These are stored in arrays A and B.

When all words have been entered this program must be altered to the Word-testing program before Saving on to cassette by Goto200. Of course, the ZX-81 saves variables with the program but, whatever you do, you must not Run this program, as this will clear the arrays. When the program is reloaded it automatically starts, and when all words have been tested the program begins again.

It is essential that C$ is dimensioned — so that its length is fixed at 12 characters — the same as B$(N), as otherwise it will be impossible for it to be equal to B$(N).

Score is kept as X, which is incremented when line 150 is true. To conserve memory only the top two lines of the screen are used to display:

TEST WORD	SCORE
YOUR TRY	ANSWER

Pause is used instead of a For-Next timing loop and the program entirely fills 1K.

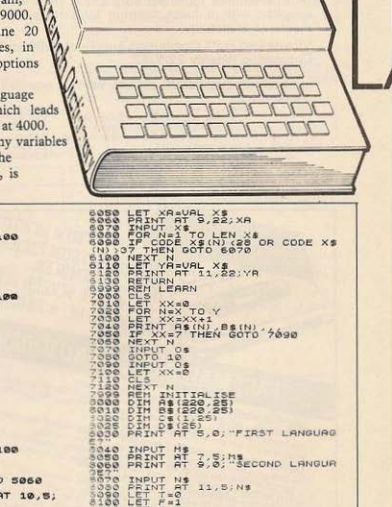
Only 20 words could be included in this initial program, but different versions could be made containing different words. For storage of more words more memory is essential — hence the development of the Vocab 16K program which not only stores 220 words or phrases, each 25 characters long, but also includes a range of useful options: adding words, testing yourself, learning and dictionary. One of the most perplexing problems was arranging for the facility to swap the two languages around, whilst ensuring that the arrays did not become garbled.

To initialise the program when it is first used, Run 8000 which Dims the arrays and sets up the other variables, before requesting the languages to be used. This was not included in the menu to avoid disastrous accidents to filled arrays. Do not forget you must never Run the program if you use Break to stop it. To save the program, plus variables, at any point Goto 9000.

The user-friendly menu at line 20 first prints the selected languages, in the order entered, and then the options available.

If you want to reverse the language order you simply input X, which leads to the language-swap subroutine at 4000. This swaps M$ and N$ via dummy variables K$ and L$. At the same time the language-swap status variable, T, is swapped between 0 and 1 so that the swap status is always indicated. If Add-words is selected the screen is cleared at line 3000 and the word select subroutine at line 6000 called. This asks where in the main arrays to start and end addition, prompting you with the current start and end numbers. To delete words simply overwrite them.

Lines 6010-6040 and 6080-6100 reject anything other than numbers. As the numbers often exceed nine this has to be done via string slicing, and the final strings must therefore be converted to simple variables by the Val function — 6050 and 6110. This subroutine is used by both Add-word and Test routines. On return the word display routine is called —



The 16K ZX-81 language program.

```
   5 REM VOCAB COPYRIGHT K + S D
RAIN 010602
   9 REM MENU
  10 CLS
  20 PRINT M$,N$,"VOCABULARY"
  30 PRINT AT 5,0;"TO TEST YOURS
ELF INPUT ""T"";AT 7,0;"TO CONS
ULT DICTIONARY INPUT ""D"";AT 9
,0;"TO ADD WORDS INPUT ""A"";AT
11,0;"TO LEARN INPUT ""L"""
  40 PRINT AT 20,0;"FOR SWAPPING
LANGUAGES INPUT ""X"""
  45 REM MENU SELECTION
  50 INPUT Q$
  60 IF Q$="T" THEN GOTO 1000
  70 IF Q$="D" THEN GOTO 2000
  80 IF Q$="A" THEN GOTO 3000
  90 IF Q$="L" THEN GOTO 7000
 100 IF Q$="X" THEN GOSUB 4000
 110 IF Q$="X" THEN GOTO 10
 120 GOTO 50
 999 REM TEST
1000 CLS
1010 PRINT "TEST"
1020 PRINT AT 5,0;"FOR RANDOM WO
RDS INPUT ""R"";AT 7,0;"FOR PAR
TICULAR WORDS INPUT ""P"""
1025 REM RANDOM OR PARTICULAR
1030 INPUT P$
1040 IF P$="P" THEN GOSUB 6000
1050 IF P$="P" THEN GOTO 5000
1060 IF P$="R" THEN GOTO 1300
1070 GOTO 1040
1100 PRINT AT 9,0;"HOW MANY WORD
S?"
1110 INPUT W$
1120 FOR N=1 TO LEN W$
1130 IF CODE W$(N)<28 OR CODE W$
(N)>37 THEN GOTO 1110
1140 NEXT N
1150 LET W=VAL W$
1160 PRINT AT 9,20;W
1165 REM RANDOM START
1170 LET M=INT (RND*Y)+1
1175 REM VALID START ELSE MALVE
1180 IF M+W>Y THEN LET M=M-2
1190 IF M+W>Y THEN GOTO 1180
1195 IF M<1 THEN LET M=1
1200 LET X=M
1210 LET YA=M+W-1
1220 GOTO 5000
1999 REM DICTIONARY
2000 CLS
2010 PRINT M$,N$,"DICTIONARY";AT
5,0;"INPUT UNKNOWN WORD";AT 20,
0;"STOP INPUT ""X"""
2020 INPUT D$
2030 IF D$(1)="X" THEN GOSUB 400
0
2040 IF D$(1)="X" THEN GOTO 2000
2050 IF D$(1)=" " THEN GOTO 10
2060 PRINT AT 7,1;D$
2065 FAST
2070 REM SEARCH ARRAY
2075 FOR N=X TO Y
2080 IF T=0 THEN GOSUB 4100
2090 IF D$=B$(N) THEN GOTO 2130
2095 IF T=0 THEN GOSUB 4100
2100 NEXT N
2105 REM NO MATCH
2110 PRINT AT 10,5;"NOT IN DICT
ION"
2120 GOTO 2140
2125 REM MATCH
2130 PRINT AT 10,1;A$(N)
2135 IF T=0 THEN GOSUB 4100
2140 SLOW
2145 FOR N=1 TO 50
2150 NEXT N
2170 GOTO 2000
3000 CLS
3010 GOSUB 6000
3020 GOSUB 5000
3030 IF T=0 THEN GOSUB 4100
3040 RETURN
3999 REM LANGUAGE SWAP
4000 LET K$=M$
4010 LET L$=N$
4020 LET M$=L$
4030 LET N$=K$
4040 LET T=F
4050 LET P=E
4060 LET F=P
4070 LET E=T
4080 RETURN
4099 REM ARRAY SWAP
4100 LET C$(1)=A$(N)
4110 LET E$=B$(N)
4120 LET A$(N)=E$
4130 LET B$(N)=C$(1)
4140 RETURN
4999 REM WORD DISPLAY
5000 FOR N=XB TO YB
5010 IF T=0 THEN GOSUB 4100
5020 CLS
5030 PRINT AT 5,5;M$
5040 IF T=1 THEN GOSUB 4100
5050 IF D$<>"A" THEN GOTO 5060
5060 PRINT AT 7,1;B$(N);AT 10,5;
M$
5069 REM TEST BRANCH 2
5070 IF D$<>"A" THEN GOTO 5130
5080 INPUT A$(N)
5090 PRINT AT 12,1;A$(N)
5100 FOR M=1 TO 50
5110 NEXT M
5120 GOTO YRA
5125 GOTO 5175
5130 INPUT C$(1)
5140 PRINT AT 12,1;C$(1);AT 14,1
;A$(N)
5150 FOR M=1 TO 50
5160 NEXT M
5165 REM CHECK MATCH
5170 IF C$(1)=A$(N) THEN LET Z=Z
+1
5175 IF T=0 THEN GOSUB 4100
5180 NEXT N
5190 IF Q$="R" THEN GOTO 10
5195 REM SCORE
5200 PRINT AT 20,5;"SCORE = ";Z
5210 FOR M=1 TO 70
5220 NEXT M
5230 LET Z=0
5240 GOTO 10
5999 REM WORD SELECT
6000 PRINT AT 9,6;"START WORD NU
MBER?";AT 11,0;"END WORD NUMBER?
";AT 15,0;"INPUT ""Y"""
6010 INPUT X$
6020 FOR N=1 TO LEN X$
6030 IF CODE X$(N)<28 OR CODE X$
(N)>37 THEN GOTO 6010
6040 NEXT N
6050 LET XB=VAL X$
6060 PRINT AT 9,22;XB
6070 INPUT Y$
6080 FOR N=1 TO LEN Y$
6090 IF CODE Y$(N)<28 OR CODE Y$
(N)>37 THEN GOTO 6070
6100 NEXT N
6110 LET YB=VAL Y$
6120 PRINT AT 11,22;YB
6130 RETURN
6999 REM LEARN
7000 CLS
7010 LET XX=0
7020 FOR N=X TO Y
7030 LET XX=XX+1
7040 PRINT A$(N),B$(N);
7050 IF XX>7 THEN GOTO 7090
7060 NEXT N
7070 INPUT Q$
7080 GOTO 10
7090 INPUT Q$
7100 LET XX=0
7110 CLS
7120 NEXT N
7999 REM INITIALISE
8000 DIM A$(220,25)
8010 DIM B$(220,25)
8020 DIM C$(25)
8025 DIM D$(25)
8030 PRINT AT 5,0;"FIRST LANGUAG
E?"
8040 INPUT M$
8050 PRINT AT 7,5;M$
8060 PRINT AT 9,0;"SECOND LANGUA
GE?"
8070 INPUT N$
8080 PRINT AT 11,5;N$
8090 LET T=0
8100 LET F=1
8110 LET P=1
8120 LET E=0
8130 LET X=1
8140 LET Y=1
8150 LET Z=0
8200 GOTO 10
9000 SAVE "VOCAB 16K"
9010 GOTO 10
```

```
V1K WORD LOADER PROGRAM
  10 DIM A$(20,12)
  20 DIM B$(20,12)
  30 DIM C$(1,12)
  110 FOR N=1 TO 20
  120 CLS
  130 INPUT A$(N)
  140 PRINT A$(N)
  150 INPUT B$(N)
  160 PRINT B$(N)
  170 PAUSE 100
  180 NEXT N
```

```
V1K WORD TESTING PROGRAM
  100 LET X=0
  110 FOR N=1 TO 20
  120 CLS
  130 PRINT A$(N),
  140 INPUT C$(1)
  150 LET X=X+NOT C$(1)<>B$(N)
  160 PRINT C$(1),X;CHR$ 24,N,B$(N)
  170 PAUSE 100
  180 NEXT N
  190 GOTO 100
  200 SAVE "V1K"
  210 GOTO 100
```

YOUR LANGUAGE

Keith and Steven Brain's ZX-81 and Dragon routines help you and your micro become multilingual.

5000. This is also used by both Add and Test routines, but with different branches. It cycles through the arrays from the selected start to the selected end — 5000, after checking the status — T — of the languages M$ and N$ — this is done at line 5010.

If these have been swapped then the word-swap subroutine at 4100 is next called. This swaps A$(N) and B$(N) via dummy variables. The first language is printed and, if Add was selected — Q$="A" — an input — B$(N) — is requested and printed, followed by the second language, and a second input request — A$(N). After a delay — 5100 — the word end counter, Y, is reset to the new end-word number — 5120, and if the languages have been reversed from their original order, then A$(N) and B$(N) are swapped back — 5175. When all words have been added the program returns to the menu.

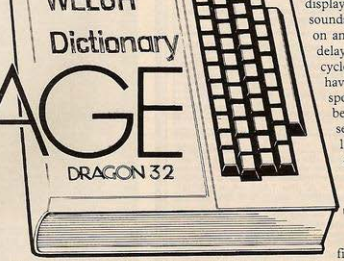
If Test is now selected the choice subroutine — 1000 — allows selection of particular or random words. If particular words are required, the appropriate Start and End number are selected as before — 6000. The random option asks the number of words required, W, and selects a random start position H at line 1170. If H+W is greater than the total number of words currently in the array, Y, then H is halved — 1180 — and this is repeated — 1190 — until H+W is less than Y, when the program passes to the word-display routine — 5000. Whether random or particular words are selected this subroutine operates as for adding words, except that the sequence is: Print first language, line 5030; Print A$(N); Input C$(1), Print C$(1), print A$(N), the correct answer, line 5140. If your try was correct the score — Z — is incremented — 5170 — and when all words have been tested your final score is displayed.

The Learn subroutine at line 7000 prints the first seven pairs of words and then waits for an input. If there were only seven words or less in the file then any input leads back to the menu. If there were more than seven words any input displays the next seven pairs of words.

The final option is the Dictionary, line 2000, which prints the languages and requests input of the unknown word. Languages can be swapped by X as before and Newline alone returns to the menu. When an unknown word is entered, it is compared with the contents of the appropriate array. If a match is found the matching word is printed, otherwise the "word not found" message comes up. This subroutine is run in Fast mode to speed it up but, if you prefer waiting a little longer to watching the screen flash then delete lines 2065 and 2140.

This 16K ZX-81 program is obviously more useful than the 1K version, and any additional memory available can be utilised simply by changing the Dim statements in lines 8000 and 8010.

When a Dragon 32 was purchased and conversion of the ZX-81 program was considered, it was soon apparent that the Dragon had a number of distinct advantages in this learning application. The first of these was the ability to store data files on cassette separate from the program, so that the relatively short master program could be used for any number of different data files containing different words or languages.



The second difference was in the Basic array-handling routines. Whereas in the ZX-81, array elements must be of fixed length, Microsoft supports variable length array elements. In practice, this means that memory is saved as space is not wasted on blanks completing unused array points. This allowed the program to be more flexible and the length of phrases to be up to 255 characters.

The third point was the ability to control a cassette recorder and TV sound with the Motor and Audio commands, making inclusion of a speech track possible. The fourth point was the high-resolution graphics which allowed display of non-standard characters such as accents.

Finally, multiple-statement lines make complex programming easier and sound and colour can be used to liven up the proceedings.

The same outline skeleton was used, but with certain additions. As the data is loaded separately, the program always initialises the arrays and other variables and requests the languages — line 11000. The menu, line 1030, is left via Inkey$, line 1050, rather than Input, and the ASC value of Inkey$ is used to sound a note to remind you of your choice. Where lower-case letters, which are inverse on-screen are used, unsightly gaps between words are avoided by using BL$, which is set to CHR$(128), instead of a space between words.

A new cassette Load-Save routine is included — Line 8000. Selection of Save — 8010 — requests File-name, Start and End positions. The cassette motor is turned on to allow you to position the data tape and when you are ready a data file is opened and the languages (M$, N$), swap status (T) and array contents saved. Selection of Load also requests filename, Start and End positions. These need not be the same as those used when these words were Saved, but can be offset so that words can be moved around the arrays. Languages — M$ and N$ — swap status, T, and words are then read in 8030.

The Audio routines — 9000 — allow Saving and Loading of both data and voice, 9030. If Save is selected a data file is opened and loaded as before, line 9060. When Saving is complete, instructions are given to alter the cassette leads at line 9080. Each selected word is now displayed — Line 9100 — and, when a tone sounds, the recorder is automatically turned on and you speak the word. After a short delay, the next word is displayed and the cycle continues until all selected words have been dealt with. In this way, a spoken-word file follows immediately behind the word data file. When Play is selected, the data file is read back — line 9120 — and speech playback only, or speech and display can then be chosen.

If the display and speech option is chosen, the first language and first word are displayed, and the recorder automatically plays the first spoken word through the TV speaker.

The program as described so far is excellent as long as neither of the languages uses accents, but even this difficulty can be solved if the characters are drawn on the hi-res screen instead of being printed — see *Your Computer*, February 1983.

This approach requires addition of appropriate character-drawing lines — 31-90 — and handling routines. The little-used upper case #, $, %, and & have been replaced by ` ´ ¨ ^ and ç, for French text but any keys can be modified in this way. We have stuck labels on to the front edge of these keys to show their new functions.

Line 20 checks that a character is valid and, if so, line 30 selects the appropriate Draw subroutine. Two different types of the hi-res display are needed — 100 — according to whether an existing string is to be read or an Input is to be made. These are indicated as MD=1 and MD=2.

If MD=2, line 300, a string — R$ — is simply sliced and each character drawn in turn. If an Input is required, life is more difficult. Only Inkey$ can be used without losing the hi-res display. If the Inkey$ character is Enter and any character has already been loaded, this is read as the same as a normal Enter and Input mode is left. If Inkey$ is not backspace — left cursor — the equivalent character is displayed, and then added on to the end of TM$ — a temporary storage string.

If backspace is used, the previous character is erased from the screen. Once the handling

(continued on page 103)

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(continued from page 101)

routines have been set up, those program lines which are to display accented words must be modified.

The modifications have the following form: Select mode: (if MD = 2 then fill RS1); set Screen position: GOSUB100 and repeat. Screen position is set by drawing a line of length (zero) at the appropriate point on the screen. Addition of this accent facility considerably enhances the value of the program. ■

Vocab 32.

```
999 :INTRODUCTION
1000 CLS0:PRINT@5,"VOCAB 32";:PRINT@194,"A VERSATILE LANGUAGE-LEARNING";:PRINT@
230,"PROGRAM FOR THE TANDON";:PRINT@300,"COPYRIGHT V. 6 5 BRAIN 1001983";:SCREEN0,
1:FORN=1TO255STEP5:SOUNDN,1:NEXT:SCREEN0,0:GOTO11000
1009 :LANGUAGE SWAP
1010 SOUNDRSC(G#),2:K$=M$:L$=N$:M$=L$:N$=K$:T=F:F#=F:F=T:E=T:RETURN
1019 :ARRAY SWAP
1020 CB(.)=RA(N):ES=B$(N):RA(N)=ES:B$(N)=CS(.):RETURN
1029 :MENU
1030 CLS:PRINT@9,NN:PRINT@42,"vocabulary";:PRINT@90,"TO TEST YOURSELF PRESS 'T'";
PRINT@160,"TO CONSULT DICTIONARY PRESS 'D'";:PRINT@220,"TO ADD WORDS PRESS 'A'";P
RINT@294,"TO LEARN PRESS 'L'";:PRINT@480,"to";BL$;"reverse";BL$;"languages";BL$;"
Press 'R'";
1040 PRINT@357,"TO SRVE/LORD PRESS 'S'";:PRINT@418,"TO USE AUDIO TAPE PRESS 'U'"
1049 :MENU SELECTION
1050 @=INKEY$:IF@="T"THEN2000ELSEIF@="D"THEN3000ELSEIF@="A"THEN4000ELSEIF@=
"L"THEN9000ELSEIF@="S"THEN8000ELSEIF@="U"THEN9000ELSEIF@="R"THENGOSUB1010:GOT
O1030:ELSE1050
1999 :TEST
2000 SOUNDRSC(G#),5:CLS2:PRINT@13,"test";:PRINT@99,"FOR RANDOM WORDS PRESS 'R'";
:PRINT@161,"FOR PARTICULAR WORDS PRESS 'P'";:SCREEN0,1
2009 :RANDOM OR PARTICULAR
2010 P$=INKEY$:IFP$="R"THENPRINT@293,"HOW MANY WORDS? ";:INPUTH:ELSEIFP$="P"THE
NGOSUB8000:GOTO5000:ELSE2010
2019 :RANDOM START
2020 H=INT(RND(V)*H)
2029 :VALID START ELSE HALVE
2030 IF(H+W)>Y THEN H=H/2
2040 IF(H+W)>Y THEN 2030ELSEIFH<1THEN H=1
2050 X=RND(V):X=H+W-1:CLS:GOTO5000
2999 :DICTIONARY
3000 SOUNDRSC(G#),5:CLS3:PRINT@,NN:PRINT@74,"dictionary";:PRINT@453,"for";BL$;"
menu";BL$;"Press 'M'";:PRINT@166,"INPUT UNKNOWN WORD";:PRINT@224,"";:INP
UTD$:IFD$=""THEN1030ELSEIFD$="X"THENGOSUB1010:GOTO3000
3009 :SEARCH ARRAY
3010 FORN=X TO Y:IFT=0THENGOSUB1020ELSEIFD$=B$(N)THEN3050ELSEIFT=0THENGOSUB1020
3020 IFD$=B$(N)THEN3050ELSEIFT=0THENGOSUB1020
3030 NEXTN
3039 :NO MATCH
3040 PRINT@352,"word";BL$;"not";BL$;"found";:GOTO3060
3049 :MATCH
3050 PRINT@352,A$(N):IFT=0THENGOSUB1020
3060 FORN=1TO1000:NEXT:GOTO3000
3999 :ADD WORDS
4000 SOUNDRSC(G#),5:CLS8:GOSUB6000:GOSUB5000:IFT=0THENGOSUB1020
4010 RETURN
4999 :WORD DISPLAY
5000 FORN=X TO Y:CLS:IFT=0THENGOSUB1020
5009 :TEST BRANCH 1
5010 PRINT@332,MD;:IFQ$(X)="THEN5020ELSEPRINT@64,"";:INPUTB$(N)
5019 :TEST BRANCH 2
5030 IFQ$(X)="THEN5040ELSEPRINT@208,"";:INPUTA$(N):PRINT@208,A$(N):FORM=1TO500:N
EXTM:VOTO5050
5039 :CHECK MATCH
5040 PRINT@208,"";:INPUTC$:PRINT@384,A$(N);:FORM=1TO500:NEXT:IFC$=A$(N)THEN Z=Z+
1:SOUND150,1:ELSESOUND1,5
5050 IFT=0THENGOSUB1020
5059 :SCORE
5060 NEXTN:IFQ$="A"THENGOTO1030ELSEPRINT@490,"score = ";Z;:FORM=1TO500:NEXTM:Z=0
:GOTO1030
5999 :WORD SELECT
6000 PRINT@320,"FILE ENDS AT";Y:INPUT"START WORD NUMBER";XR:INPUT"END WORD NUMBE
R";YR:RETURN
6999 :LERNUM
7000 SOUNDRSC(G#),5:CLS6:XW=0:FORW=X TO Y:XW=XW+1:PRINT@K(W),,B$(N),,,,,,IFXW=5TH
EN7010ELSENEXTN:INPUTD$:GOTO1030
7010 INPUTD$:XW=0:CLS:NEXTN:GOTO1030
7999 :CASSETTE LORD/SRVE
8000 SOUNDRSC(G#),5:CLS4:PRINT"S.cassette";BL$;"file";BL$;"routine";:PRINT@34,"
TO LORD WORD FILE PRESS'L";:PRINT@66,"TO SAVE WORD FILE PRESS 'S";
8009 :LORD OR SRVE?
8010 CF$=INKEY$:IFCF$="L"THEN8020ELSEIFCF$="S"THEN8050ELSE8010
8019 :LORD
8020 PRINT@134,"load";:PRINT@166,"FILE NAME";:INPUTFN$:PRINT@220,"START WORD NUMB
ER ";:PRINT@262,"CURRENT START IS ";X;:PRINT@258,"";:INPUTFS:PRINT@294,"END WO
RD NUMBER ";:PRINT@326,"CURRENT END IS ";Y;:PRINT@314,"";:INPUTFE
8030 MOTORON:PRINT@384,"WHEN TAPE READY PRESS 'ENTER';";INPUTZ$:MOTOROFF:INPUTZ$
:OPEN"I",#-1,LUB:INPUT#-1,LU,MB,NB,T:FORN=FS TO FE:PRINT#-1,A$(N),B$(N):NEXTN:CLO
SE#-1:PRINT@458,"saved";:SOUND200,50:GOTO1030
8999 :AUDIO
9000 SOUNDRSC(G#),5:CLS2:PRINT@7,"audio";BL$;"routine";:PRINT@64,"THIS ENABLES YO
U TO INCLUDE AN AUDIO TRACK WITH THE PROGRAM";
9010 CLS3:PRINT@33,"CONNECT DRAGON CASSETTE LEADS";:PRINT@72,"TO THE RECORDER";:
GOTO9020
9020 PRINT@262,"TO RECORD PRESS 'R';:PRINT@327,"TO PLAY PRESS 'P'";
9029 :RECORD OR PLAY
9030 Z#=INKEY$:IFZ#="R"THEN9040ELSEIFZ#="P"THEN9110ELSE9030
9039 :AUDIO RECORDING
9040 CLS4:PRINT@0,"audio";BL$;"recording";:GOSUB10000
9050 MOTORON:PRINT@394,"WHEN TAPE AT CORRECT POINT";:PRINT@70,"PRESS 'ENTER';";IN
PUTZ$:MOTOROFF:PRINT@97,"PRESS 'RECORD' THEN 'ENTER';";INPUTZ$
9060 OPEN"O",#-1,"AUDIO":PRINT#-1,28,MB,NB,T,RE,AS:FORN=AS TO AE:PRINT#-1,A$(N),
B$(N):NEXTN:CLOSE#-1:PRINT@360,"word";BL$;"file";BL$;"saved"
9070 PRINT@410,"VOICE TRACK CAN NOW BE ADDED";:PRINT@483,"WHEN READY PRESS 'ENTE
R';:INPUTZ$
9080 CLS4:PRINT@33,"UNPLUG DRAGON MICROPHONE LEAD";:PRINT@66,"AND REPLACE WITH M
ICROPHONE";:PRINT@162,"EACH WORD WILL BE DISPLAYED";:PRINT@197,"ON THE SCREEN IN
TURN";:PRINT@258,"WHEN TONE SOUNDS SPEAK WORD";:PRINT@307,"TO START PRESS 'ENTE
R';:INPUTZ$
9089 :WORD DISPLAY
9090 FORN=AS TO AE:CLS2:IFT=0THENGOSUB1020:A$(N)ELSEQ$=B$(N)
9100 PRINT@165,CB;:PRINT@370,"";:SOUND200,2:MOTORON:FORM=1TO1000:NEXTM:MOTOROFF:P
RINT@370,"";:NEXTN:PRINT@425,"All";BL$;"words";BL$;"entered";:SOUND200,10:GOTO10
00
9189 :AUDIO PLAYBACK
9110 CLS3:PRINT@0,"audio";BL$;"playback";:GOSUB10000
9120 PRINT@65,"WHEN READY PRESS 'ENTER';";INPUTZ$:OPEN"I",#-1,"AUDIO":INPUT#-1,Z
,MB,NB,T,AE,AS:FORN=AS TO AE:IFEOF(-1)THEN9130:INPUT#-1,A$(N),B$(N):NEXTN:PRINT
@360,"word";BL$;"file";BL$;"loaded";
9130 CLOSE#-1:PRINT@417,"VOICE TRACK CAN NOW BE REPLAYED";:PRINT@483,"WHEN READY
 PRESS 'ENTER';";INPUTZ$
9139 :WORDS END/OR SOUND?
9140 CLS2:PRINT@128,"FOR SOUND TRACK ONLY INPUT 'S';";PRINT@192,"FOR SOUND + SCR
EEN INPUT 'B';";INPUTZ$
9150 CLS4:FORN=XR TO YR:CLS4:IFT=0THENGOSUB1020
9160 PRINT"press",BL$;"enter",BL$;"for";BL$;"stop";:PRINT@32,MB;IFZ$="
B"THENPRINT@NB;
9170 MOTORON:AUDIOON:PRINT@28,"";:INPUTZ$:MOTOROFF:AUDIOOFF:PRINT@256,NB;:PRINT
@288,"";:INPUTC$:PRINT@384,A$(N);:FORM=1TO500:NEXTM:IFC$=A$(N)THENSOUND200,1ELSE
SOUND1,5
9180 IFT=0THENGOSUB1020
9190 NEXTN:GOTO1030
9999 :WORD SELECT 2
10000 PRINT@164,"START WORD NUMBER";:PRINT@196,"FILE START IS ";X;:PRINT@194,"
";:INPUTRS:PRINT@260,"END WORD NUMBER";:PRINT@292,"FILE END IS ";Y;:PRINT@290,"
";:INPUTRE:RETURN
10999 :TIME
11000 PCLERR4:DIM#(R#/500):DIM#B(500):DIMC$(.):DIMD$,F$(.):P$(.):M$(.):V$(.):
CLS2:PRINT@2,"enter";BL$;"language";BL$;"(";BL$;"be";BL$;"used";:PRINT@128,"
FIRST LANGUAGE";:INPUTM$:SOUND20,1:PRINT@224,"SECOND LANGUAGE";:INPUTN$:SOUND50,
1:GOTO1030
```

Additional lines for accent capability.

```
1 :CLEAR10000:PCLS
9 :DRAW BRAM ROUTINES
10 GOTO1000
19 :VALID CHARACTER?
20 CC=PEEK(CC0):IFCC<32ORCC>90THENRETURN
29 :SELECT CMP LINE
30 ON CC-31 GOSUB32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,
53,54,55,56,57,59,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79
,80,81,82,83,84,85,86,87,88,89,90:RETURN
31 :DRAW CMP ROUTINES
32 DRA1$=B$+B$:RETURN
33 RETURN
34 DRA1$=B$+.-6DEN+2,+9UBM+4,+6":RETURN
35 DRA1$=B$+.-7H3BM+7,+10":RETURN:RETURN
36 DRA1$=B$+.-8,-7E2F3BM+4,+7":RETURN
37 DRA1$=B$+.-6,+1BGR+7,-3":RETURN
39 DRA1$=B$+.-6DEN+4,+5":RETURN
40 DRA1$=B$+.-4BM4BEM+4,+7":RETURN
41 DRA1$=B$+1,+6EU4BHM+5,+6":RETURN
42 DRA1$=B$+.-1E4BM+8,+4H4BH+8,+5":RETURN
43 DRA1$=B$+.-3R4L2U2D4BM+5,+1":RETURN
44 DRA1$=B$+1,+9DGBM+4,-2":RETURN
45 DRA1$=B$+.-3R4BM+4,+3":RETURN
46 DRA1$=B$+1,+8UBM+4,+1":RETURN
47 DRA1$=B$+.-1E4BM+4,+5":RETURN
48 DRA1$=B$+.-1FR2EU4HL2GD4BM+8,1":RETURN
49 DRA1$=B$+.-8U4DBM+7,+5":RETURN
50 DRA1$=B$+4,+8L4UER2EU2HL2GBM+8,+5":RETURN
51 DRA1$=B$+.-1FR2EUL2R2EUL2GBM+8,+5":RETURN
52 DRA1$=B$+3,+8U6GR4BM+4,+3":RETURN
53 DRA1$=B$+.-1FR2EU2HL3U2BM+8,+5":RETURN
54 DRA1$=B$+.-2ER2FDGL2HU4ER2FBM+4,+5":RETURN
55 DRA1$=B$+2,+8U2EDGL4BM+8,+5":RETURN
56 DRA1$=B$+1,+8R2EUL2HU6ER2FDGL2GDFBM+7,+8":RETURN
57 DRA1$=B$+0,-1FR2EU4HL2GDFR3BM+4,+3":RETURN
58 DRA1$=B$+0,-5DBM+8,+2DGBM+4,+1":RETURN
59 DRA1$=B$+0,-5DBM+8,+2DGBM+5,+8":RETURN
60 RETURN
61 DRA1$=B$+0,-2R4BM+8,-2L4BM+8,+4":RETURN
62 RETURN
63 DRA1$=B$+2,+8UBM+8,-1UREUHLGBM+7,+5":RETURN
64 RETURN
65 DRA1$=B$R2FD3UL4BM+8,+3":RETURN
66 DRA1$=B$R3DGFDGL3U3R3BM+5,+3":RETURN
67 DRA1$=B$+1,+8U4ER2FL2GZ4FR2EBM+4,+1":RETURN
68 DRA1$=B$R3FD4GL3BM+8,+8":RETURN
69 DRA1$=B$+4,4U3R4L4U3R4BM+4,+5":RETURN
70 DRA1$=B$R4L4U3R4BM+4,+6":RETURN
71 DRA1$=B$+1,+8R2EUL8DGL2HU4ER2FBM+4,+5":RETURN
72 DRA1$=B$U3D3GL4BM+4,+8":RETURN
73 DRA1$=B$+2,+8R2LUL8R2BM+4,+6":RETURN
74 DRA1$=B$+1,+8R2EUL2BM+4,+6":RETURN
75 DRA1$=B$BM+8,+3RE3GF3BM+4,+8":RETURN
76 DRA1$=B$R4L4U8BM+8,+6":RETURN
77 DRA1$=B$R2ED6BM+4,+8":RETURN
78 DRA1$=B$U6D4U6BM+8,+6":RETURN
79 DRA1$=B$+1,+8R2EUHL2GD4FBM+7,+8":RETURN
80 DRA1$=B$R3FDGL3BM+8,+3":RETURN
81 DRA1$=B$+1,+8R2EUHL2GD4FBM+1,-2F2BM+4,+8":RETURN
82 DRA1$=B$R3FDGL3RF3BM+4,+8":RETURN
83 DRA1$=B$+0,-1FR2EU4ER2FBM+4,+5":RETURN
84 DRA1$=B$+2,+8UEL2R4BM+4,+6":RETURN
85 DRA1$=B$+1,+8DFR2EUBM+4,+5":RETURN
86 DRA1$=B$+0,-5D4F2EUBM+4,+6":RETURN
87 DRA1$=B$+0,-5D4E2FUBM+4,+6":RETURN
88 DRA1$=B$+1,+8U4BM+8,+4H4BH+8,+6":RETURN
89 DRA1$=B$+2,+8U4H2F2EBM+4,+6":RETURN
90 DRA1$=B$+1,+8U4EL4BM+8,+6":RETURN
99 :MI-RES SCREEN - READ OR INPUT?
100 PROCDA:I:SOUND255,1:PCLOR3:PRAM"S4":ON MD GOSUB200,300:RETURN
199 :INPUT AND ERASE ROUTINE
200 CB=INKEY$:IFCB<"THEN200ELSEIFCB<CHR$(13)ORCLEN(TM$)>8THENRETURNELSEIFCB
<>CHR$(13)THENGOSUB200:TM$=TM$+CB$:GOTO200:ELSEDRAW"C1BM-8,+6U18D18R18D18U18RD
18BM-5,-6G0"
210 LINE(0)HT$(TM$,1):LA=ASC(LR$):IFLA<350R LA >39THENTM$=LEFT$(TM$,LEN(TM$)-1)
GOTO200:ELSE TM$=LEFT$(TM$,LEN(TM$)-2):GOTO200
299 :REMO TIMING
300 FORJ=1TOLENR$:CC$=MID$(R$,J,1):GOSUB200:NEXT:RETURN

2999 :DICTIONARY
3000 SOUNDRSC(G#),5:PCLS1:MD=2:R$=M$+"/"+N$:DRAW"BM10,10" GOSUB100 R$="DICTIONAR
Y":DRAW"BM63,30" GOSUB100 R$="FOR MENU PRESS NEUL;BM"+STR$(MD)+",120" GOSUB100 R$
="INPUT UNKNOWN WORD":DRAW"BM40,60" GOSUB100:MD=1:DRAW"BM70,90" GOSUB100 D$=TM$:
TM$=""
3005 IFASC(D$+13)THEN1030ELSEIFD$="X"THENGOSUB1010:GOTO3000
3010 FORN=X TO Y:IFT=0THENGOSUB1020ELSEIFD$=B$(N)THEN3050ELSEIFT=0THENGOSUB1020
3020 IFD$=B$(N)THEN3050ELSEIFT=0THENGOSUB1020
3030 NEXTN
3040 R$="NO WORD FOUND":DRAW"BM50,120" GOSUB100 GOTO3060
3050 MD=2:R$=A$(N):DRAW"BM50,120" GOSUB100:IFT=0THENGOSUB1020

4999 :WORD DISPLAY
5000 FORN=X TO Y:IFT=0THENGOSUB1020
5010 PCLS1:MD=2:R$="B:"+STR$(MD):DRAW"BM10,20" GOSUB100:IFQ$(X)="THEN5020ELSEMD=1:DRAW"BM20
,40" GOSUB100:R$(N)=TM$:TM$=""
5020 MD=2:R$="DRAW BM10,100" GOSUB100 R$=B$(N):DRAW"BM23,40" GOSUB100
5030 IFQ$(X)="THEN5040ELSEMD=1:DRAW"BM20,120" GOSUB100 A$(N)=TM$:TM$="":FORM=1TO
500:NEXTM:GOTO5050
5040 MD=1:DRAW"BM20,120" GOSUB100 C$=TM$:TM$="":MD=2 R$=B$(N):DRAW"BM20,160" GOS
UB100:FORM=1TO500:NEXT:IFC$=A$(N)THEN Z=Z+1:SOUND150,1:ELSESOUND1,5
5050 IFT=0THENGOSUB1020
5060 NEXTN:IFQ$="A"THENGOTO1030ELSEMD=2:DRAW"BM50,105":R$="SCORE = "+STR$(Z):GOS
UB100:FORM=1TO500:NEXTM:Z=0:GOTO1030

6999 :LERN
7000 SOUNDRSC(G#),5:PCLS:XW=0:FORN=X TO Y:MD=2:LINE(10,30*10)-(10,30*10),PRESET-
R$=B$(N):GOSUB100:LINE(10,30*10+20)-(10,30*10+20),PRESET:R$=B$(N):GOSUB100:XW=XW+1
:IFXW=15THEN7010ELSENEXTN
7005 IFM$="E"THEN7010ELSEIFM$="C"THEN7020ELSE7030
7010 CB=INKEY$:IFCB<"THEN7010ELSEXW=0:PCLS:NEXTN:GOTO1030

9009 :WORD DISPLAY
9090 FORN=AS TO AE:PCLS:IFT=0THENGOSUB1020:A$(N)ELSEQ$=B$(N)
9100 MD=2:R$=CB:DRAW"BM40,40" GOSUB100:SOUND200,1:MOTORON:FORM=1TO1000:NEXTM:MOT
OROFF:NEXTN:R$="ALL WORDS ENTERED":DRAW"BM40,160" GOSUB100 SOUND200,10 GOTO1030

9149 :AUDIO + WORD DISPLAY
9150 FORN=AS TO AE:PCLS:IFT=0THENGOSUB1020
9160 MD=2:R$="PRESS ENTER TO STOP TAPE":DRAW"BM10,10" GOSUB100 R$="press":DRAW"BM10,50"
0" GOSUB100:IFZ$="B"THENR$=B$(N):DRAW"BM10,50" GOSUB100
9170 MOTORON:AUDIOON:ZZ=INKEY$:IFZZ<>""THEN9170ELSEMOTOROFF:AUDIOOFF R$=B$(N):DRAW
"BM10,100" GOSUB100 MD=1:DRAW"BM10,120" GOSUB100:C$=TM$:TM$="":MD=2:R$=B$(N):DRAW
"BM10,150" GOSUB100:FORM=1TO500:NEXTM:IFC$=A$(N)THENSOUND200,1ELSESOUND1,5
```

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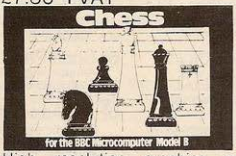

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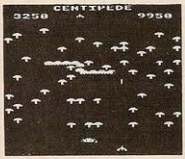

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EASY ATOM CODES

If your Atom seems hostile about giving away information, Vincent Fojut's error-message handler might not exterminate all errors — but should certainly help you correct them.

PUTTING IT KINDLY, the error codes provided by the Acorn Atom's standard error handler can be rather unhelpful at times. Just what is error 191? Newcomers to the machine need a little more encouragement if they are not to be put off by their inevitable mistakes. Even the more experienced Atom user can save himself the frustration of checking on the meanings of the less frequent error codes.

The short machine-code program — listing 2 — alleviates the problem by providing an English language error-message handler in place of the standard error routine. For maximum utility, the normal error codes and Basic line number references are still provided. Total memory requirements, for the machine code and error-message data table, are in the order of 1.25K, though this will very depending on the length and number of the error messages stored.

Before we can print the English messages for each error, we first need a convenient means of entering them into the machine. The Basic program in listing 1 facilitates the required data entry. As you can see from the short sample run in figure 1, the entry program prompts the user for an error code, which must be between 0 and 255 inclusive, and then its associated error message is requested.

As a helpful starting point, a list of all the operating system errors, and their respective translations into English, can be found in the Atom user manual, *Atomic Theory and Practice*, on pages 205 to 209. The meaning of each error can be typed in verbatim, if desired. There is, however, nothing to stop you modifying these messages — shortened lengthened, rephrased or typed in Swahili — to suit your own particular requirements.

To terminate data entry, type 999 in response to the Error number? prompt. Alternatively, the program will terminate automatically if there is insufficient memory to store another error message — see lines 340 to 360, listing 1.

When data entry is completed, the program returns the number of messages stored, and prints a suitable COS command to save the entire message table for future use. The lazier ones amongst you, who wish to avoid retyping, can enter this command by using the cursor-control and Copy keys.

Once the data table has been created and stored, the Basic program is no longer required. It can safely be overwritten by your current program or application. Remember that if you wish to use mode 4, the highest resolution graphics, you will need to store the machine-code routine and the data table in lower text space, say, at # 3700 onwards, as in the program examples. If mode 4 is not required, then anywhere in the upper 3K of graphics RAM — # 8C00 to # 97FF — can be used.

Figure 2 shows how the messages are stored in the data table. Each entry consists of an error number, followed by a message in ASCII. Both upper- and lower-case ASCII characters are permitted. Note, however, that the byte containing the first character in each ASCII string has its top bit set to 1. This gives the new error routine a convenient means of detecting the end of any message string — it need only look for a byte with a negative value.

The end of the message table is marked by two consecutive bytes of value zero. You may perhaps wonder why two bytes were necessary, as opposed to just one, since there is no Basic error with a number of 0. The reason is that the value zero could itself be a valid error code — as could any eight-bit value — if the routine were to be used by machine-code programs. Since no restriction has been placed on the order of error numbers during data entry, it follows that an error code of zero could occur anywhere in the message table. A double-byte end-of-table marker avoids any such potential confusion.

Listing 2 details the modified error-handling routine. The Break vector at # 202, # 203 is modified so that whenever a 6502 BRK instruction is executed — for example during the normal trapping of a Basic error — processing is rerouted via this program. The routine scans through the user-defined error message table until a match is found for the current error number stored on the processor stack. As soon as a match is found, the appropriate message string is printed. This is followed by the standard Atom error output, so that you can isolate the offending Basic line.

If no match for the error code can be found, the program jumps straight into the normal Atom error routine.

In testing this routine, I hit upon what appears to be a little-known fact about the Acorn Atom. The BRK vector — BRKVEC at # 202, # 203 — unlike the other operating system vectors, cannot be changed by Basic in direct mode. To demonstrate this, try entering the following directly — that is, without line numbers:

```
?#204=#AB;?#205=#CD change IRQ
  vector
P.&?#204,&?#205 should give AB,CD —
  that is, vector changed
```

Press Break to restore the IRQ vector's original contents, # A000. However:

```
?#202=#AB;?#203=#CD change BRK
  vector
```

(continued on page 109)

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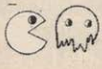

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(continued from page 107)

*P.&?#202,&?#203 still gives D8,C9 — that is, vector not changed

As far as our new routine is concerned, the effects of this are twofold. Firstly, any program which uses the new error handler must immediately alter the BRK vector to the new start address. Secondly, the new messages will not be displayed for Basic errors caused by a direct-mode line, unless the same Basic line redirects the BRK vector first. In practice, this second point is no real problem. Any direct-mode error will obviously be due to the line just entered and should, therefore, be relatively easy to identify.

Now that you have entered or loaded your message table and modified error routine, how do you use it? Figure 3 shows a simple Basic program which causes the new error handler to be executed. Note that the very first thing the program does is to change the BRK vector — we assume that the machine code has been stored at address #3700 onwards.

Once this is done, you may enter your Basic program as normal. You have the added assurance that when run, your program will be able to identify any errors in as precise and as meaningful a way as you choose — see the sample run in figure 3.

Machine-code programs may also use the error handler to good effect. As an example, consider the program in figure 4. The routine adds #40 to the value stored at address #0090. If the byte at this address is #3F or less, then the sum of the addition is stored at address #0091, as in Sample run A. If the byte is # or greater, then the addition will set the processor's overflow flag. When such an overflow occurs, a suitable error message can be displayed by invoking the new error handler via a BRK instruction — see Sample run B.

The value of the error code generated by any BRK instruction is calculated by adding 2 to the BRK instruction's address, and shedding the high byte of the result. In the example in figure 4, the BRK will be located at #3614, which generates an error number of #3614+2=#3616=a low byte of #16 or 22 decimal. If a suitable error message is added to the message table for this error number, then it will be displayed whenever the overflow occurs.

Note that, like its Basic counterpart, the machine-code program firstly redirects the BRK vector. This must always be done, unless the machine code is being called from a Basic program which itself modifies the vector.

The more adventurous may like to modify the data-entry program so that control characters may be easily embedded within the error-message strings. This could for example enable you to clear the screen before displaying certain error messages.

In addition, the size of the message table could be reduced to some extent through the use of text compression techniques, with text expansion routine in the new error handler. Concise message phrasing also helps. ■

Figure 2.

```
3080- 45 (BASIC Floating-Point error number)

3081- 49 6C 6C 65 67 61 6C 20 46 44 43 4D 20 73 74 61 74 65 6D 65 6E 74
        I  l  l  e  g  a  l     F  D  I  M     s  t  a  t  e  m  e  n  t

3097- 16 (Machine Code error number - see Figure 4)

3098- 53 69 67 6E 65 64 20 61 72 69 74 68 65 74 69 63
        S  i  g  n  e  d     a  r  i  t  h  m  e  t  i  c

3025- 10 6F 76 65 72 66 6C 6F 77
        o  v  e  r  f  l  o  w+#80

3032- 5B (BASIC error number)

3033- 4C 6F 20 68 65 78 61 64 65 63 69 6D 61 6C
        L  o     h  e  x  a  d  e  c  i  m  a  l

3041- 20 6E 75 6D 62 65 72 20 61 66 74 65 72 20 22 22 2D
        n  u  m  b  e  r     a  f  t  e  r     "  "-#80

3052- 0 0 (End of Table marker)
```

Figure 4.

```
  10 DIM LL(1)
  20 FOR N=0 TO 1: LL(N)=1: NEXT N
  30 FOR N=1 TO 2: P=#3600
  40 E
  50\LL0 LDA #0     \set up
  60     STA #202   \vector
  70     LDA #37    \for new
  80     STA #203   \err. routine
  90                \(start address
 100                \of #3700 assumed)
 110     LDA #90
 120     CLC
 130     ADC #40
 140     BVS LL1    \overflow?
 150     STA #91
 160     RTS
 170\LL1 BRK        \IRQ to err.
 180                \handler.
 190\
 200 NEXT N: END
--- ( "RUN" to assemble machine code ) ---
- Sample run A - (no error)
>?#90=#3F
>LINK#3600
>P.&?#91 '
      7F
- Sample run B - (overflow)
>?#90=#40
>LINK#3600

Signed arithmetic overflow
ERROR 22
```

Listing 1.

```
  10 REM ****************************************************
  20 REM ERROR MESSAGE ENTRY PROGRAM FOR MCORN ATOM.
  30 REM STORES AN ASSOCIATED MESSAGE FOR EACH ERROR CODE ENTERED
  40 REM (C) V. FOJUT. 1982.
  50 REM
  60 REM INSTRUCTIONS ****************************************
  70 PRINT ''WHEN PROMPTED, ENTER AN ERROR''
  80 PRINT ''NO., FOLLOWED BY AN ASSOCIATED  ERROR MESSAGE OF ''
  90 PRINT ''YOUR CHOICE.''
 100 PRINT ''TO TERMINATE, ENTER AN ERROR NO. OF '999'''
 110 REM
 120 INPUT ''START ADDRESS OF MESSAGE TABLE  (HEX) '' M
 130 T=M:    REM SAVE TABLE ADDRESS
 140 T=0:    REM FLAG T = ''FALSE''
 150 W=0:    REM NO. OF ENTRIES
 160 REM
 170 DO
 180  PRINT
 190  DO
 200   INPUT ''ERROR NUMBER'' E
 210  UNTIL (E)=0 AND (E)256) OR E=999
 220  IF E=999 THEN T=1: GOTO W: REM  CHECK FOR TERMINATION.
 230  TMM=E:                     REM  PUT ERROR CODE IN TABLE
 240  M=M+1:                     REM  INCREMENT POINTER.
 250  DO
 260   PRINT ''ENTER MESSAGE''
 270   INPUT M$
 280  UNTIL LEN(M$)>0
 290  W=W+1:                     REM  INCREMENT NO. OF ENTRIES
 300  M=M+LEN(M$):               REM  POINT TO NEXT FREE BYTE
 310                             REM  PAST END OF MESSAGE.
 320  M1=INT(M/256):             REM  SET TOP BIT OF LAST
 330                             REM  CHAR. IN MESSAGE.
 340  M?66=M55:                  REM  CHECK IF ENOUGH MEMORY
 350  IF M?66&X0!=NAR THEN PRINT''OUT OF MEMORY'': T=1
 360                             REM  T='TRUE' IF OUT OF MEM.
 370\UNTIL T;                    REM  I.E. UNTIL FLAG T='TRUE'
 380 REM
 390 TM=0: REM END OF TABLE MARKER
 400 B=1:
 410 PRINT ''NUMBER OF ENTRIES = '' W'
 420 PRINT " &SAVE"ERRTAB"~&2" ~&M+2'
 430 END
```

Listing 2.

```
  10 REM ****************************************************
  20 REM  ENHANCED ERROR HANDLER FOR MCORN ATOM.
  30 REM  ALLOWS STANDARD ERROR CODES TO BE PRECEDED BY A
  40 REM  USER-SUPPLIED ENGLISH (OR ANY OTHER) LANGUAGE ERROR
  50 REM  MESSAGE.
  60 REM  (C) V. FOJUT. 1982.
  70 REM ****************************************************
  80 REM
  90 DIM LL(10)
 100 FOR N=0 TO 10: LL(N)=1: NEXT N
 110 M=#00: Z=#02: REM ZERO-PAGE MEMORY USED BY ROUTINE
 120 INPUT "ASSEMBLE FROM (HEX)" M
 130 INPUT "START ADDRESS OF MESSAGE TABLE  (HEX)" T
 140 FOR M=1 TO 2: P=M
 150E
 160\LL0 STA Z          \save
 170     STX Z+1        \registers.
 180     STY Z+2
 190     LDA #7/256     \set
 200     STA M+1        \up
 210     LDA #7&256     \table
 220     STA M          \pointer.
 230     TSX
 240     LDY #0         \initialise Y.
 250\LL1 LDA (M),Y      \current error
 260\LL2 CMP #1&0,X     \in table?
 270     BEQ LL4        \branch if so.
 280\LL3 JSR LL7        \get next char.
 290     BPL LL3        \until end of mess. string
 300     JSR LL7        \get next err.no.
 310     BNE LL2        \if not zero.
 320     JSR LL7        \end of table?
 330     BEQ LL6        \branch if so
 340     TYA            \else
 350     BNE LL9        \check
 360     DEC M+1        \table
 370\LL5 DEY            \for
 380     CLC            \error
 390     BCC LL1        \code.
 400\
 410\ entry found for current error - print message
 420\
 430\LL4 JSR #FFD2      \CR/LF
 440\LL5 JSR LL7        \get next char.
 450     PHP            \save char.
 460     AND #7F        \mask out top bit.
 470     JSR #FFF4      \print char.
 480     PLP            \restore char.
 490     BPL LL5        \continue if more.
 500\
 510\ end of string
 520\
 530\LL6 LDX Z          \restore
 540     LDY Z+1        \registers.
 550     LDY Z+2
 560     PLP            \get ccFx
 570     PHP            \of status
 580     JMP #C9D8      \jump to
 590                    \standard
 600                    \err.handler.
 610\
 620\ Get next char. routine.
 630\
 640\LL7 INY            \increment
 650     BNE LL8        \table
 660     INC M+1        \pointer.
 670\LL8 LDA (M),Y      \get next char.
 680     RTS            \return.
 690\
 700 NEXT N
 710 B=1
 720 PRINT " &SAVE"ERRPROC"~&A~ &LP"
 730 END
```

Figure 1.

```
>RUN

WHEN PROMPTED, ENTER AN ERROR
NO., FOLLOWED BY AN ASSOCIATED
ERROR MESSAGE OF YOUR CHOICE.
TO TERMINATE, ENTER AN ERROR NO.
 OF '999'

START ADDRESS OF MESSAGE TABLE  (HEX) ?#3000

ERROR NUMBER?69
ENTER MESSAGE
?Illegal FDIM statement

ERROR NUMBER?22
ENTER MESSAGE
?Signed arithmetic overflow

ERROR NUMBER?91
ENTER MESSAGE
?No hexadecimal number after "#"

ERROR NUMBER?999

NUMBER OF ENTRIES = 3

 *SAVE"ERRTAB"3000 3054
```

Figure 3.

```
  10 ?#202=0:?#203=#37: REM SET UP VECTOR FOR NEW ERR. ROUTINE
  20                    REM (START ADDRESS OF #3700 ASSUMED)
  30 A=#7F
  40 B=#T               REM THIS MONTH'S DELIBERATE MISTAKE!
  50 C=A+B
  60 PRINT C
  70 END

>RUN

No hexadecimal number after "#"
ERROR 91 LINE      40
```

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BASIC DICTIONARY

This dictionary, compiled by Tony Edwards, will explain the function of common Basic words as used in popular machines, enabling you to work out your own machine's equivalent. A useful complement to our recent series on Basic dialect translation.

PROC A reserved word which starts a user-declared numeric procedure on the BBC Micro.

PTR An unusual statement pair used by the BBC Microcomputer to allow selection of the next byte to be transferred between program and file, giving random type access.

R

R. The TRS-80, level 1, and Palo Tiny Basic abbreviation for the RUN command.

RAD A function which converts degrees to radians.

RANDOM A statement which resets the seed to be used for the random number generator. Its use — usually without argument — allows different pseudo-random series to be generated each run.

RANDOMISE The standard ANSI word — though little used — for the RANDOM functions.

REA The PDP-80E abbriviation for READ. The same abbreviation followed by a full stop is used in TRS-80 level 1 and Palo Alto Tiny Basic.

READ A standard ANSI statement which causes data to be read from a Data line elsewhere in the program. The read data are assigned to variables.

RECALL The Apple II function which causes the computer to input data from a cassette drive.

RENAME The statement used to rename a current file. It requires two arguments, the old name and the new name.

REM A standard ANSI word used to indicate that the interpreter should ignore the following line or part of a line.

REMARK The same statement as REM.

RENUM The Microsoft abbreviation for RENUMBER.

RENUMBER The command which re-numbers the lines of a resident Basic program and simultaneously adjusts the addresses to Jump commands to maintain program logic.

REPEAT . . . . UNTIL A BBC Micro statement. It produces a loop which is repeated until the specified condition is true. A single REPEAT may have multiple UNTILs. This statement is not often available in Basic but can be simulated — see *Your Computer*, June 1982 page 44.

RES The PDP-8E abbreviation for RESTORE.

RESET The TRS-80 statement which switches off a specified pixel.

REST. The TRS-80, level 1, abbreviation for RESTORE.

RESTORE A standard ANSI word which causes the DATA pointer to be reset. This has the effect of causing the next READ statement to operate on the first of a program's data. In some machines a partial RESTORE is possible.

RESUME The statement used as a target of an ON ERROR GOTO routine. It directs the computer to continue execution from the line named in the argument.

RET The PDP-8E abbreviation for the RETURN statement. The TRS-80 level 1 and Palo Alto Tiny Basic use the same abbreviation followed by a full stop.

RETURN The standard ANSI statement used to complete a GOSUB routine.

RIGHT- A function which isolates a specified number of string characters starting from the right-most character. It is sometimes used with a "$" appended.

RND A standard ANSI function which returns a random number. Its use is non-standard in some Basics and details are given in *Your Computer*, August 1982, page 59. The statement RND (–X) when used on the Apple II is equivalent to RANDOM.

RU An abbreviation for RUN.

RUN A command which causes a computer to start executing the program resident in its memory.

S

S. The TRS-80 level 1 and Palo Alto Tiny Basic abbreviation for STEP.

SAVE A widely-used command which causes a program, resident in the memory, to be copied on to a cassette, or in some cases on to disc.

SCRN A special function used on the Apple II which returns a value identifying the colour of a specified graphics block.

SET The statement used in TRS-80 Microsoft Basic which turns on a graphics block specified by its arguments.

SGN A logical function which returns –1,0 or +1 depending respectively on the argument being negative, zero or positive.

SIN An ANSI standard function which returns the sine of its argument. The argument should usually be started in radians.

SLEEP A statement used to cause the suspension of program execution for the number of tenths of a second specified by the argument.

SPACE A function used to print a number of spaces in an output. The number being specified by the argument. Sometimes a $ is appended to this word.

SPC Similar function to SPACE. In the case of the BBC Micro the number of spaces inserted is argument module 256.

SQR The ANSI standard word for the function which returns the square root of a positive number.

SQRT The same as SQR.

ST An abbreviation for the STEP function.

ST. The TRS-80 level 1 abbreviation for STOP.

STEP A standard ANSI word used as part of a FOR . . TO . . STEP function which indicates the size of the increment by its argument which can usually be positive, negative, or non-integer.

STO An abbreviation for STOP.

STOP A statement which halts the execution of a program and puts the computer in the ready mode. A standard ANSI word.

STR$ A useful function which converts a numerical value into its string equivalent.

STRING$ A function which prints a ASCII character a specific number of times. The character code and the number of repeats being the arguments. In some computers the actual character, in quotes, can be the argument.

STUFF A statement used on Opus 1 and 2 machines to place integer values between 0 and 256 in specified memory addresses.

SYS An abbreviation for SYSTEM.

SYSTEM A command and a statement which places the computer into the monitor mode to handle machine-language programs directly.

T

T. This abbreviation is used in TRS-80 level 1 Basic to mean both THEN or TAB. The interpreter recognises the TAB meaning if it is followed by a numeral in parenthesis. For example,

means	T.(10)
and	TAB 10
means	T.10
	THEN 10

TAB A standard ANSI word which is used in conjunction with PRINT statements. it causes the cursor, or printer carriage, to move to a position corresponding to the number used as an argument from the left-hand edge of the line. ■

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SPLIT SCREEN

■I wish to write a program on my Spectrum, part of which involves scrolling the top half of the screen up and down, and the top left-hand and right-hand quarters of the screen to left and right individually. Please could you explain how this could be done?

Peter Rutty,
Luton,
Bedfordshire.

THE EASIEST WAY to do this is to hold the contents of each segment of the screen in a long string. You then print the string in segments, using Print At. For example, to print the left-hand corner, you could use a sequence such as:

```
PRINT AT 0,0; A$( TO 7);AT 1,0; A$(8 TO 16); AT 2,0; A$ (17 TO 25)
```

and so on.

SOLDER JOY

■Following the article in *Your Computer* on converting Atari joysticks for use on a Sinclair ZX-81, I would like to know if machine-code programs which use the arrow keys for movement will automatically run using the joystick. Also, is it worth the trouble of soldering the chips, or would I be better off buying a ready-made Sinclair joystick?

S Ray,
Ipswich,
Suffolk.

UNFORTUNATELY, machine programs using the cursor keys will not automatically run using joystick. Programs have to be tailored very carefully to the actual joystick used. Whether or not is it worth making conversions for yourself, for joysticks or other peripherals, depends largely on your confidence in working with electrical components. If you have any doubts, I would suggest you would be better off buying a unit ready-made.

MOD TROUBLE

■I have come across a program in a book which uses the Mod command. Could you tell me how to make this program run on my computer, which does not have Mod?

Martin James,
Notting Hill,
London W11.

DAVID LIEN'S *Basic Handbook*, published by Compusoft, California, points out that the Mod command which prints the remainder of a division — Print 23 Mod 4 will give 3, the remainder when 23 is divided by 4 — can be emulated as follows. The form of the command generally is X Mod Y. To make A equal to X Mod Y, when your computer does not have Mod, include the line

```
A = INT(Y*(X/Y)) + .001
```

You will find that Lien's book is an invaluable aid when trying to convert programs from foreign Basics into the dialect used by your own computer.

CAT PEOPLE

■I have been the proud owner of a large ginger cat for over four months. I realise the limitations of my cat, but I was wondering if you could help me with one particular problem. I also own a ZX-81 which has been damaged by my ginger cat, who pushed it off the edge of the table. The computer will now no longer load programs which I once taped, and if I try to save programs, there is a fluctuating whistle with a very much reduced program signal. I would be very grateful if you could tell me what the fault is, and how it can be corrected.

F Floor,
Hampton,
Middlesex.

I MUST admit I was not sure what you were going to ask when you started talking about your, cat, but once you mentioned the computer being knocked to the floor I realised the letter was not a joke, as I had at first feared. Despite all that, I am afraid I can not help you. Diagnosis of hardware faults by letter is a notoriously thankless task. I am afraid you will have to send your computer back to Sinclair Research for repair. It is very unlikely that Sinclair will also be able to do something about your cat.

PERICLES RULES

■I am waiting delivery of my BBC model A. In the meantime, I am writing some programs for it. I would be pleased if you could tell me if the following statement, in immediate mode,

```
MODE 7. PRINT CHR$
(130);"PERICLES";CHR$(132);
"PERICLES"
```

will print the name in two different colours? That is, is it possible to have more than one foreground colour in the same line?

P J Isahageas,
Attica,
Greece.

THERE IS NO restriction on the use of different foreground colours on a single line mode 7 on the BBC computer, except for the fact that each colour control character — that is, the CHR$(130) or whatever — takes up a single space, so a blank appears every time there is a control character. If blanks do not bother you, you could have the different letters of your name chosen randomly. The following program would do this.

```
 10 GOSUB 100
 20 PRINT"P";:GOSUB 100
 30 PRINT"E";:GOSUB 100
 90 GOTO 10
100 PRINT CHR$(128 + RND(6));
110 RETURN
```

TIME BOMB

Recently I acquired a copy of a certain program from a friend. When I list the program, there is a line 6411 in between lines 877 and 1010. It reads

```
6411 cursor STRUCTIONS
```

in inverse. When I run the program, and try and input something, I obtain error code C/6411. I wonder if you could tell me why this happens — it runs on my friend's computer.

Stephen Richards,
Billingshurst,
West Sussex.

IN THE FIRST place, copying commercial software is robbing the programmer of his or her royalties, so I am afraid I can have little sympathy for you if you have copied a program which your friend bought. It is quite possible that the company which made the software has set a time bomb such as you describe to stop illegal copies from running. The way to remove the odd line is to Poke the exact address where the line is held. Determining such an address is not easy to do. If the program you are copying is not a commercial program, it seems that either your computer has corrupted the program, or it was corrupted by your friend's computer when Saving it. Sometimes an electrical discharge, like an electrical appliance starting up in the house during the Saving process, can put a corrupting "blip" on the program, producing similar results to those you describe.

KEY FEELINGS

■I am considering buying an Atari 400 computer because of the vast amount of software available for it. I was wondering if you could tell me of an easy way to put a real keyboard on the Atari when I receive it.

Andrew Knowe,
Edinburgh.

FIRST, I WOULD suggest you do not judge the Atari 400 keyboard too harshly until you have tried it. After the frustration of working on membrane keyboards like the ZX-81, you could be forgiven for believeing the Atari 400 would also be annoying to program, but you may not find it so. I find the 400 a pleasant computer to work with, because the keys have little raised edges, which make for a much more positive feel than the smooth membrane keyboards like the ZX-81. As well as this, the keyboard gives a positive bleep every time you hit a key, and this audio feedback makes typing easy. There is at least one company selling add-on keyboards for the 400, but I would work with the computer before deciding that one of these is vital.

THE STORK TEST

Is there any way of checking that my Sinclair Spectrum 48K is, in fact, a 48K model? There seems to be no external distinguishing feature to identify the two different models.

C Browning,
Hampton,
Middlesex.

IF YOU LOOK through the hole in the back of the computer, where the Printer plugs in, you will see a number of circular brown objects on a 48K model. These are not present on the 16K version. If you enter

```
DIM A$(40,000)
```

as a direct command on your computer, and you obtain an out-of-memory report code, you have a 16K machine.

SHOP AROUND

■As a new reader, in need of some advice, I wish to buy a home computer, mainly for good quality education and games program. I am contemplating buying a Dragon 32, as it seems to have some good specification at a budget price. Could you tell me if I would be restricted to buying only the software supplied by the manufacturer of the computer? I am very keen to buy some Acornsoft items, such as Snapper, Monsters and Defender, and I need to know whether or not these would be compatible. Also, would I need to buy any accessories, such as a tape unit extended RAM, or whatever?

P Wilson,
Lancaster Road,
London W11.

ALTHOUGH YOU are not restricted to software produced by the manufacturer or distributor of the particular computer you buy, you are restricted to software which is written for the computer which you have bought. Acorn software, whether for the Atom or the BBC Microcomputer, will not run on the Dragon. If you like this software so much, it may be well worth considering buying an Acorn computer. Unless you buy a disc unit for your computer — and many of the cheaper computers do not, as a rule, support discs — you will have to obtain a cassette tape player to be able to load software into your computer. Exceptions to this include the Texas TI-99/4A which accepts plug-in cartridges for programs. You cannot, however, save your own programs on to cartridges. A tape or disc unit is needed for this. ■

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FINGERTIPS

Fingertips is our regular calculator column covering calculator news, programming hints and examples of unusual applications. The column is written and compiled by calculator enthusiast David Pringle who is glad to hear of any of your ideas. *Your Computer* pays £6 for each of your contributions published.

THE FIRST program this month comes from Albert Ball of Warrington, for his CBM PR-100. The program performs the basics of Boolean Algebra and is intriguing in being the first calculator program I have seen to do this. Boolean algebra refers to the logical combination of binary codes and can be used in some up-market calculators. Applications of the work are seen not only in computing but digital electronics.

The following sequences can be used to evaluate logical expressions. The two logical values are assumed stored in M1 and M2 but any memories can of course be used.

AND MR 1 X MR 2 = 6 steps

OR MR 1 + MR 2 = x

F INT 9 steps

INVERT MR 1 +/- + 1 = 6 steps

EXCLUSIVE OR MR 1 + MR 2 ÷ 2 x F FRAC 2 = 12 steps

These sequences can be chained together to compute results for more complex expressions. For example, the expression (A.B) + (C.D) gives the following sequence:
(A in M0, B in M1, C in M2 and D in M3) MR 0 x (MR 1 +/- + 1) + ((MR 2 +/- + 1 x MR 3) +/- + 1) = √x F INT R/S.

A further program is useful for presetting memory contents prior to evaluating expressions when establishing truth tables. Memory contents can be set manually, of course, but this becomes tedious if many variables are involved, or if many states have to be analysed as for truth tables.

A decimal number is entered manually and the program runs as many times as there are memories to be set. The effect is to load the memories to be set, in other words load the memories with binary digits corresponding to the decimal number entered. The most significant digit is in M0, the next in M1 and so on for as many digits as are needed — up to a maximum of nine.

For example, to generate a truth table for the expression quoted earlier, enter the program shown in locations 0-21 inclusive, and enter the key sequence also shown earlier from location 22 onwards.

Enter 0 — the first decimal number, Goto 00 then press R/S four times — allowing the program to stop between presses. This loads M0 to M3 inclusive with zeros. Run the expression evaluation program from 22, and the result is given. For the next value, enter 1, Goto 00 again press R/S four times. Now M0 to M2 contain zeros and M3 contains 1. Run from 22 for the next result. continuing in this way up to decimal number 15 generates a truth table.

DEC NO.	A (M0)	B (M1)	C (M2)	D (M3)	RESULT
0	0	0	0	0	1
1	0	0	0	1	0
2	0	0	1	0	1
3	0	0	1	1	1
4	0	1	0	0	1
5	0	1	0	1	0
6	0	1	1	0	1
7	0	1	1	1	1
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	1
11	1	0	1	1	1
12	1	1	0	0	1
13	1	1	0	1	0
14	1	1	1	0	1
15	1	1	1	1	1

The memory loading sequence shown uses a feature of the CBM PR-100 which is not described in the manual, that is

F x <> M F 9M

This has the effect of cycling the contents of all memories. M0 contents go to M1, M1 to M2 and so on, M9 contents go into the x register — the display — and the x register contents go into M0.

Memory Loading Program.

	0-	1-	2-
-0	÷	M	0
-1	2	0	0
-2	=	R/S	
-3	M	F	
-4	9	X<>M	
-5	F	F	
-6	FRAC	9M	
-7	x	F	
-8	2	INT	
-9	=	GOTO	

Bent Bollerup, of Denmark, has a Jackpot program for the PC-1211 that has kept his friends occupied for hours, he says.

In Def mode you press Shift A. You are asked for an initial number between 0 and 7 — up to ten digits. Enter this, and you are shown the wheels one by one, then the winnings and your total. On pressing Enter you are asked for Hold? (0-1).

010 ENTER

means hold the middle wheel. If you do not want to hold, just press Enter again and the next game is in play.

You will not be asked for Hold after winning. Hold cannot be used in two succeeding plays. Every game costs you two coins — H in line 20 — and you can win from two to 40 coins — G in line 60.

The priority of the signs is from the lowest:

/ - + * = // Y $

If you want to proceed from the last game, rather than from scratch, start on Shift B next time you turn the computer on. About the program: line 5 and sub-routine lines 190-220 generate the first random number. The random generator — lines 200-220 — is to be found in *Response Frame*, March 1982.

Lines 22 to 55 calculate the next random numbers, pick the corresponding sign, and show the wheels. Line 60 calculates the winnings — this can be adjusted by changing the fraction 8/7. Lines 70 and 90 beep 1 for every two coins you win and print the three wheels, your winnings and your total number of coins, plus or minus. Lines 100 to 170 handle the Hold function together with lines 250 and 260 and, to be specific, lines 24 and 26.

For space in the listing I have used a dot. Two dots mean two spaces.

Jackpot program for PC-1211

```
  5 "A" H=0: GOSUB 190
 10 "B" A$="..": B$="..": C$="..":
    W=0
 20 "C" H=H-2
 22 FOR X=1 TO 3
 24 IF A$(X)="." GOTO 28
 26 GOTO 55
 28 GOSUB 200
 30 A(X+11) J
 35 GOTO (J+41)
 41 A$(X)="/" GOTO 50
 42 A$(X)="." GOTO 50
 43 A$(X)="+" GOTO 50
 44 A$(X)="*" GOTO 50
 45 A$(X)="=" GOTO 50
 46 A$(X)="#  GOTO 50
 47 A$(X)="Y" GOTO 50
 48 A$(X)="$" GOTO 50
 50 PAUSE "....": A$; B$; C$
 55 NEXT X
 60 G=INT((L=M)*(M=N)*
    (6+M*2)+((L=M)+(M=N))*
    (2+M*8/7))
 70 H=H+G: BEEP G/2
 90 PRINT "....": A$; B$; C$; "...";
    G; "..TOT..": H
100 IF W<>0 LET W=0: GOTO "B"
110 IF G GOTO "B"
115 K=0
120 INPUT "..HOLD ?:(0-1).": K
125 W=K: IF K=0 GOTO "B"
130 FOR X=3 TO 1 STEP -1
140 GOSUB 250
150 IF P=0 LET A$(X)="."
```

(continued on next page)

Area by co-ordinates program for the TI-57.

```
LRN
STO 0      00      32 0        GOTO1      25      51 1
  0        01      00        2nd LBC 2    26      86 2
R/S        02      81          RCL 0      27      33 0
STO 1      03      32 1        INV SUM 3  28     -34 3
STO 2      04      32 2        RCL 6      29      33 6
  0        05      00          INV SUM 2  30     -34 2
R/S        06      81          RCL 2      31      33 2
STO 3      07      32 3        2ND SUM 3  32      39 3
  0        08      00          RCL 3      33      33 3
R/S        09      81          SUM 7      34      34 7
STO 4      10      32 4        INV SBR    35     -61
2ND LBC 1  11      86 1        LBC 4      36      86 4
  0        12      00          RCL 1      37      33 1
R/S        13      81          STO 6      38      32 6
STO 5      14      32 5        SBR 2      39      61 2
  0        15      00            2        40      02
R/S        16      81        2ND INV SUM 7 41     -39 7
STO 6      17      32 6          0        42      00
SBR 2      18      61 2        X<>T       43      22
RCL 4      19      33 4        2ND 1X1    44      40
STO 2      20      32 2        R/S        45      81
RCL 5      21      33 5        RST        46      71
STO 3      22      32 3                   47
RCL 6      23      33 6                   48
STO 4      24      32 4                   49
```

(continued from previous page)

```
160 NEXT X
170 GOTO "C"
190 INPUT "INIT..NUMBER.
    (0.TO.1).";P: Z=(P+Z)/2
200 =(Z+π)!5
210 Z=Z-INT Z
220 J=INT(Z*8): RETURN
250 P=K-INT(K/10)*10
260 K=INT(K/10): RETURN
```

Mark Vince of Halesowen has written an intriguing little program which will output exactly the factorial of any number between 1! and 237!. I await the flood of letters informing me of a quicker method. Mark uses a Casio fx-602P.

This program calculates all digits of n! for any n between 1 and 237. The program calculates all digits and displays the first few digits; successive presses of Exe then display blocks of seven digits at a time. When all digits are exhausted the letter E is displayed to signify End. Long execution times must be expected for large values of n.

Finally a program for the TI-57 from B Maddocks of Sheffield. It will calculate the area of any polygonal shape — a great improvement on Simpson's Rule. This program will give the area of any shape or cross-section from the co-ordinates of that shape based on:

$$A = \sum_{i=2}^{N} \frac{(X_1 = X_i)(Y_{(i+1)} - Y_{(i-1)})}{2}$$

when $Y_{n+1} = Y_1$

See figure 1.

PRESS	RST	DISPLAY
,,	RST	0
,,	4	4
,,	R/S	0
,,	3	3
,,	R/S	0
,,	1	1
,,	+/-	-1
,,	R/S	0
,,	2	2
,,	+/-	-2
,,	R/S	0
,,	3	3
,,	+/-	-3
,,	R/S	0
,,	2	2
,,	+/-	-2
,,	R/S	0
,,	5	5
,,	R/S	0
,,	SBR 4	33

Mark Vince's factorial program.

```
MODE.67 MODE 2
PO"#!=" MAC+/-MIN00 1 MIN01 MIN3F 7 10  MIN 1F
LBL0 1 MIN 4F OMINF LBL5 OMIN2F
LBL1 1 M+F IND MRF X MRO0+/- + MR2F = IND MINF - MR1F=≥0
GOTO 2 GOTO 3
LBL2 IND MRF - MR1F - INT MIN 2F=≥MR1F=IND MINF GOTO 1
LBL3 MRF-MR4F=≥ OM+4F MR4F-MR3F=≥ 0 GOTO 4 GOTO 5
LBL4 M+3F ISZ GOTO0 MR3F MIN 00 IND MR00 LOG INT MIN 1F
LBL6 IND MR00  MR1F 10  FRAC IND MIN 00 =  ":#" MR1F 10 × IND
MR00=IND MIN00 1 M-1F MR1F X 0 GOTO 6 6 MIN1F ";" HLT"" DSZ
GOTO6 "E"
```

Figure 1. Area by co-ordinates

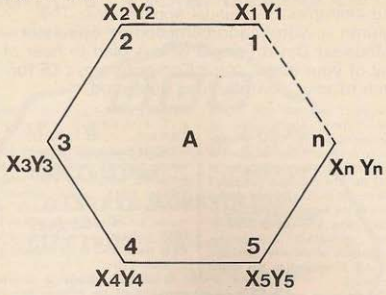
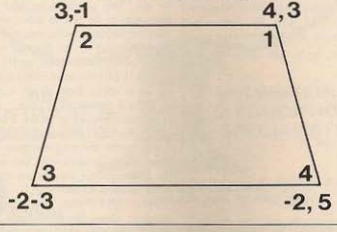


Figure 2. Follow co-ordinates clockwise or anti-clockwise



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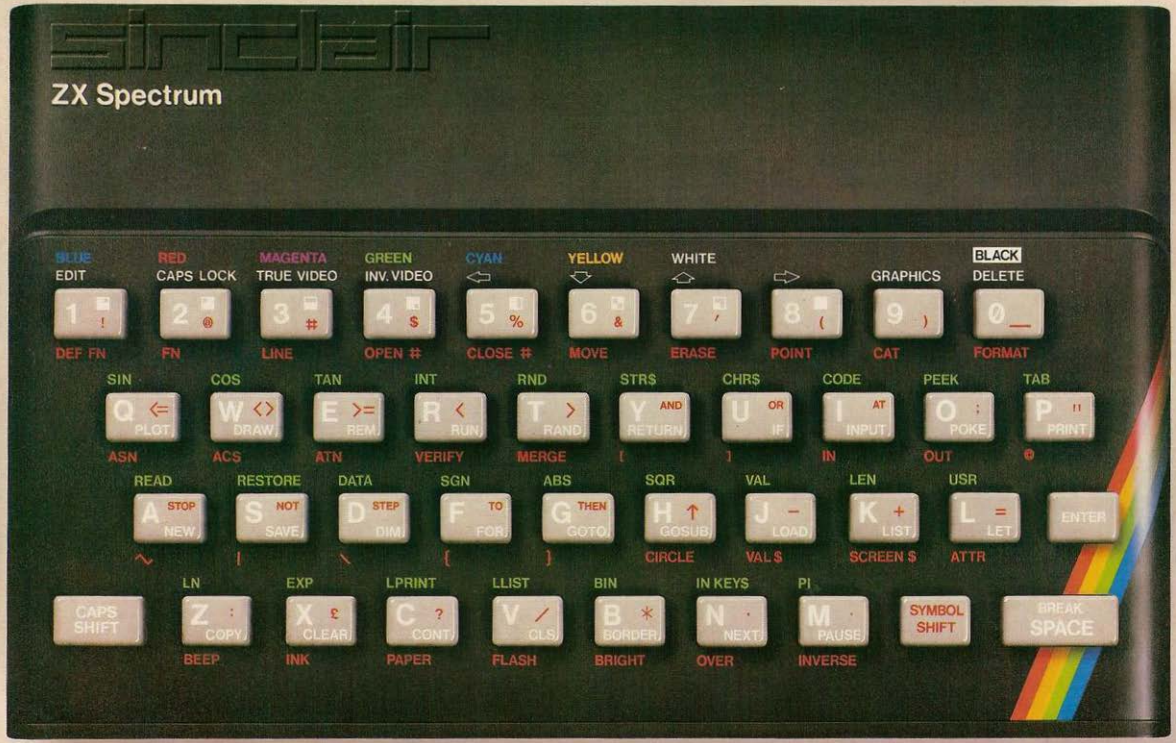
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ZX Spectrum
BLUE
EDIT
RED
CAPS LOCK
MAGENTA
TRUE VIDEO
GREEN
INV. VIDEO
CYAN
YELLOW
WHITE
GRAPHICS
BLACK
DELETE
1 !
2 @
3 #
4 $
5 %
6 &
7 '
8 (
9)
0 _
DEF FN
FN
LINE
OPEN #
CLOSE #
MOVE
ERASE
POINT
CAT
FORMAT
SIN
COS
TAN
INT
RND
STR$
CHR$
CODE
PEEK
TAB
Q <= PLOT
W <> DRAW
E >= REM
R < RUN
T > RAND
Y AND RETURN
U OR IF
I AT INPUT
O ; POKE
P " PRINT
ASN
ACS
ATN
VERIFY
MERGE
[
]
IN
OUT
@
READ
RESTORE
DATA
SGN
ABS
SQR
VAL
LEN
USR
A STOP NEW
S NOT SAVE
D STEP DIM
F TO FOR
G THEN GOTO
H ↑ GOSUB
J − LOAD
K + LIST
L = LET
ENTER
~
|
\
{
}
CIRCLE
VAL $
SCREEN $
ATTR
LN
EXP
LPRINT
LLIST
BIN
IN KEYS
PI
CAPS SHIFT
Z : COPY
X £ CLEAR
C ? CONT
V / CLS
B * BORDER
N , NEXT
M . PAUSE
SYMBOL SHIFT
BREAK SPACE
BEEP
INK
PAPER
FLASH
BRIGHT
OVER
INVERSE

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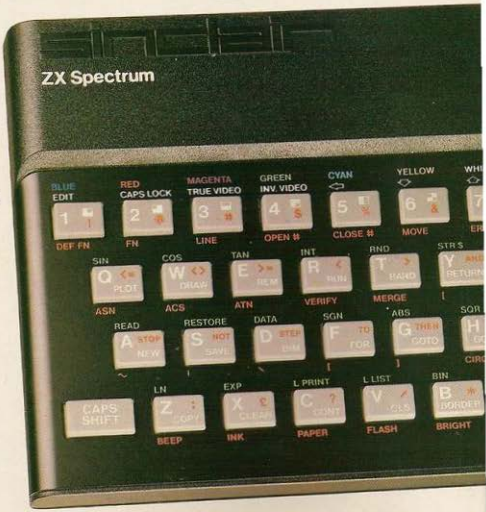


First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional power–personal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

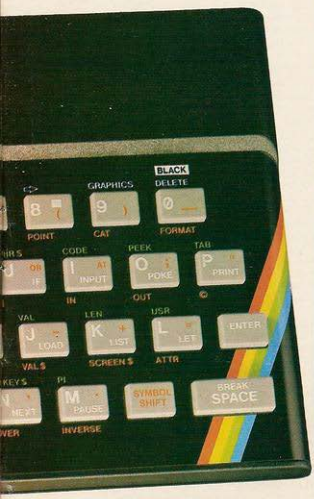
Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound – BEEP command with variable pitch and duration.
- Massive RAM – 16K or 48K.
- Full-size moving-key keyboard – all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution – 256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set – with upper- and lower-case characters.
- Teletext-compatible – user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE – 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC – incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

um



ZX Spectrum software on cassettes – available now

The Spectrum software library is growing every day. Subjects include games, education, and business/household management. Flight Simulation...Chess...Planetoids... History...Inventions...VU-CALC...VU-3D ...Club Record Controller...there is something for everyone. And they all make full use of the Spectrum's colour, sound, and graphics capabilities. You'll receive a detailed catalogue with your Spectrum.

ZX Expansion Module

This module incorporates the three functions of Microdrive controller, local area network, and RS232 interface. Connect it to your Spectrum and you can control up to eight Microdrives, communicate with other computers, and drive a wide range of printers.

The potential is enormous, and the module will be available in the early part of 1983 for around £30.

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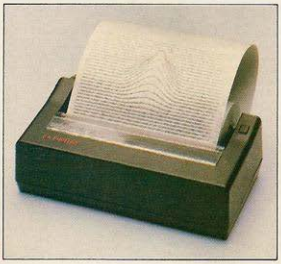
Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS.
Tel: Camberley (0276) 685311.

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.



The ZX Microdrive – coming soon

The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing by providing mass on-line storage.

Each Microdrive can hold up to 100K bytes using a single interchangeable storage medium.

The transfer rate is 16K bytes per second, with an average access time of 3.5 seconds. And you'll be able to connect up to 8 Microdrives to your Spectrum via the ZX Expansion Module.

A remarkable breakthrough at a remarkable price. The Microdrives will be available in the early part of 1983 for around £50.

How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Barclaycard, Access or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item Price £	Total £
	Sinclair ZX Spectrum – 16K RAM version	100	125.00	
	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
	Postage and packing: orders under £100	28	2.95	
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Signature

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Sinclair ZX Spectrum–technical data.

Dimensions

Width	233 mm
Depth	144 mm
Height	30 mm

CPU/ memory

Z80A microprocessor running at 3.5 MHz.
16K-byte ROM containing BASIC interpreter and operating system.

16K-byte RAM (plus optional 32K-byte RAM on internal expansion board) or 48K-byte RAM.

Keyboard

40-moving-key keyboard with full upper and lower case with capitals lock feature. All BASIC words obtained by single keys, plus 16 graphics characters, 22 colour control codes, and 21 user-definable graphics characters. All keys have auto repeat.

Display

Memory-mapped display of 256 pixels x 192 pixels; plus one attributes byte per character square, defining one of eight foreground colours, one of eight background colours, normal or extra brightness and flashing or steady. Screen border colour also settable to one of eight colours. Will drive a PAL UHF colour TV set, or black and white set (which will give a scale of grey), on channel 36.

Sound

Internal loudspeaker can be operated over more than 10 octaves (actually 130 semitones) via basic BEEP command. Jack sockets at the rear of computer allow connections to external amplifier/ speaker.

Graphics

Point, line, circle and arc drawing commands in high-resolution graphics.
16 pre-defined graphics characters plus 21 user-definable graphics characters. Also functions to yield character at a given position, attribute at a given position (colours, brightness and flash) and whether a given pixel is set. Text may be written on the screen on 24 lines of 32 characters. Text and graphics may be freely mixed.

Colours

Foreground and background colours, brightness and flashing are set by BASIC INK, PAPER, BRIGHT and FLASH commands. OVER may also be set, which performs an exclusive–or operation to overwrite any printing or plotting that is already on the screen. INVERSE will give inverse video printing. These six commands may be set globally to cover all further PRINT, PLOT, DRAW or CIRCLE commands, or locally within these commands to cover only the results of that command. They may also be set locally to cover text printed by an INPUT statement. Colour-control codes, which may be accessed from the keyboard, may be inserted into text or program listing, and when displayed will override the globally set colours until another control code is encountered. Brightness and flashing codes may be inserted into program or text, similarly. Colour-control codes in a program listing have no effect on its execution. Border colour is set by a BORDER command. The eight colours available are black, blue, red, magenta, green, cyan, yellow and white. All eight colours may be present on the screen at once, with some areas flashing and others steady, and any area may be highlighted extra bright.

Screen

The screen is divided into two sections. The top section – normally the first 22 lines – displays the program listing or the results of program or command execution. The bottom section – normally the last 2 lines – shows the command or program line currently being entered, or the program line currently being edited. It also shows the report messages. Full editing facilities of cursor left, cursor right, insert and delete (with auto-repeat facility) are available over this line. The bottom section will expand to accept a current line of up to 22 lines.

Mathematical operations and functions

Arithmetic operations of +, –, ×, ÷, and raise to a power. Mathematical functions of sine, cosine, tangent and their inverses; natural logs and exponentials; sign function, absolute value function, and integer function; square root function, random number generator, and pi.

Numbers are stored as five bytes of floating point binary – giving a range of $+3\times10^{-39}$ to $+7\times10^{38}$ accurate to 9½ decimal digits.

Binary numbers may be entered directly with the BIN function. =, >, <, >=, <= and <> may be used to compare string or arithmetic values or variables to yield 0 (false) or 1 (true). Logical operators AND, OR and NOT yield boolean results but will accept 0 (false) and any number (true).

User-definable functions are defined using DEF FN, and called using FN. They may take up to 26 numeric and 26 string arguments, and may yield string or numeric results.

There is a full DATA mechanism, using the commands READ, DATA and RESTORE.

A real-time clock is obtainable.

String operations and functions

Strings can be concatenated with +. String variables or values may be compared with =, >, <, >=, <=, <> to give boolean results. String functions are VAL, VAL$, STR$ and LEN. CHR$ and CODE convert numbers to characters and vice versa, using the ASCII code.

A very powerful string slicing mechanism exists, using the form a$ (x TO y).

Variable names

Numeric – any string starting with a letter (upper and lower case are not distinguished between, and spaces are ignored).
String – A$ to Z$.
FOR-NEXT loops – A-Z.
Numeric arrays – A-Z.
String arrays – A$ to Z$.

Simple variables and arrays with the same name are allowed and distinguished between.

Arrays

Arrays may be multi-dimensional, with subscripts starting at 1. String arrays, technically character arrays, may have their last subscript omitted, yielding a string.

Expression evaluator

A full expression evaluator is called during program execution whenever an expression, constant or variable is encountered. This allows the use of expressions as arguments to GOTO, GOSUB, etc.

It also operates on commands allowing the ZX Spectrum to operate as a calculator.

Cassette interface

The ZX Spectrum incorporates an advanced cassette interface. A tone leader is recorded before the information to overcome the automatic recording level fluctuations of some tape recorders, and a Schmitt trigger is used to remove noise on playback.

All saved information is started with a header containing information as to its type, title, length and address information. Program, screens, blocks of memory, string and character arrays may all be saved separately.

Programs, blocks of memory and arrays may be verified after saving to confirm successful saving.

Programs and arrays may be merged from tape to combine them with the existing contents of memory. Where two line numbers or variables names coincide, the old one is overwritten.

Programs may be saved with a line number, where execution will start immediately on loading.

The cassette interface runs at 1500 baud, through two 3.5 mm jack plugs.

Expansion port

This has the full data, address and control busses from the Z80A, and is used to interface to the ZX Printer, the RS232 and NET interfaces and the ZX Microdrives.

IN and OUT commands give the I/O port equivalents of PEEK and POKE.

ZX81 compatibility

ZX81 BASIC is essentially a subset of ZX Spectrum BASIC. The differences are as follows.

FAST and SLOW: the ZX Spectrum operates at the speed of the ZX81 in FAST mode with the steady display of SLOW mode, and does not include these commands.

SCROLL: the ZX Spectrum scrolls automatically, asking the operator "scroll?" every time a screen is filled.

UNPLOT: the ZX Spectrum can unplot a pixel using PLOT OVER, and thus achieves unplot.

Character set: the ZX Spectrum uses the ASCII character set, as opposed to the ZX81 non-standard set.

ZX81 programs may be typed into the ZX Spectrum with very little change, but may of course now be considerably improved. The ZX Spectrum is fully compatible with the ZX Printer, which can now print out a full upper and lower case character set, and the high resolution graphics; using LLIST, LPRINT and COPY. ZX81 software cassettes and the ZX16K RAM pack will not operate with the ZX Spectrum.

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ZX Spectrum

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SOFTWARE FILE

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Turbo

David Green,
Ashford,
Kent.

ZX-81

HERE IS A machine-code arcade-type game written for the 16K ZX-81. It will not work on a computer will less than 3.5K as the down-scroll routine, adapted from Munir Zaman's program in the January 1983 *Your Computer*, crashes if used with a minimum display file. The game itself is relatively simple involving the player controlling a car driving along a road avoiding the edges of the road and any other cars, but the incredible speed of machine code makes it enjoyable and challenging.

To enter the program, first type in a Rem statement containing 305 characters, made up of nine full lines plus 17, as the first line of the program. If you then use the direct command Poke 16510,0. This will give the first line a line number of 0, so that you cannot accidentally erase it. Next type in and run this now well-known hexadecimal loader:

```
 1 REM . . .305 characters. . .
10 LET X=16524
20 LET A$=""
30 IF A$=A"" THEN INPUT A$
40 SCROLL
50 PRINT X,A$(TO 2)
60 POKE X,16*CODE A$+CODE A$(2)-4/6
70 LET X=X+1
80 LET A$=A$(3 TO)
90 GOTO 30
```

Notice that the actual program in machine code starts at 16524, the first 10 bytes being data.

Enter the hexadecimal numbers shown in the machine-code listing: if you do not understand machine code, then these are numbers in base 16 which allow you to represent any number from 0 to 255 in just two digits — see the Sinclair manual. This loader allows you to enter as many codes as you like before pressing Newline. If you think that you have made a mistake then type S and Newline, and when the error report 3/50 appears then type Let X=an address which you know is correct, followed by Goto 20.

When you have entered the last code C9 at 16818 type S to stop, and then enter the second Basic program which prints the instructions and activates the machine code. Save the resulting program on tape as any error in the machine code could cause a system crash and the loss of your program.

Turbo: machine-code listing

16524:	*16604:*	7E	ED 4B 84 40
01 0B 00	2A 88 40	FE 00	89
ED 43 84 40	3E EF	C2 9F 41	4F
C5	DB FE	3E 26	CD F5 08
CD F5 08	F5	D7	3E 2D
C1	CB 47	*16686:*	D7
3E 80	20 07	ED 4B 84 40	*16757:*
D7	25	0C	2A 86 40
AF	7C	3A 34 40	ED 5B 88 40
D7	FE 00	CB 47	5A
D7	20 01	28 02	16 00
D7	24	0D	2B
D7	F1	0D	7C
D7	CB 4F	79	B5
3E 80	20 07	FE FF	CA AF 41
D7	24	20 01	1B
04	7C	0C	7A
78	FE 15	FE 1A	B3
FE 16	20 01	20 01	20 F5
20 E9	25	0D	22 86 40
21 0E 15	22 88 40	ED 43 84 40	*16781:*
22 82 40	*16638:*	CD F5 08	2A 88 40
21 00 05	2A 0C 40	3E 80	2B
22 86 40	01 B4 02	D7	7C
21 00 14	09	AF	B5
22 88 40	E5	D7	20 FB
21 00 00	01 21 00	D7	2A 8A 40
22 8A 40	09	D7	23
16758:	EB	D7	22 8A 40
ED 4B 82 40	E1	D7	C3 C2 40

3E F7	01 B5 02	3E 80	*16799:*
DB FE	ED B8	D7	01 00 40
CB 67	2A 0C 40	*16730:*	36 3D
20 01	06 20	3A 34 40	0B
0D	AF	E6 07	78
3E EF	23	FE 07	36 BD
DB FE	77	20 12	B1
CB 57	10 FC	3A 35 40	20 F7
20 01	ED 4B 82 40	E6 03	01 FF FF
0C	CD F5 08	3C	C9
ED 43 82 40	2A 0E 40		*16815:*
			01 00 00
			C9
			end 16818

Turbo: Basic listing

```
 0 REM . . .(machine code). . .
10 CLS
20 PRINT TAB 10;"TURBO";TAB 10;
     "■■■■■"
30 PRINT TAB 8;"(C)D.GREEN"
40 PRINT
50 PRINT "YOU HAVE TO DRIVE YOUR
     CAR ALONG THE ROAD AS FAR
     AS POSSIBLE IN A LIMITED
     AMOUNT OF TIME, AVOIDING
     THE ROADSIDES AND ANY
     OTHER CARS THAT YOU MAY
     COME ACROSS."
60 PRINT
70 PRINT "THE FASTER YOU GO, THE
     GREATER THE DISTANCE THAT
     YOU CAN TRAVEL IN THE TIME."
80 PRINT
90 PRINT "CONTROLS ARE:"
100 PRINT "(5)-MOVE LEFT", "(8)-MOVE
     RIGHT", "(0)-ACCELERATE",
     "(9)-DECELERATE"
110 FOR N=1 TO 200
120 NEXT N
130 PRINT AT 20,2;
     " PRESS ANY KEY TO START "
     (inverse video)
140 PRINT AT 20,2;"PRESS ANY KEY TO
     START"
150 IF INKEY$="" THEN GOTO 130
160 CLS
170 LET X=USR 16524
180 IF X THEN PRINT AT 1,8;"YOU HAVE
     CRASHED"
190 IF NOT X THEN PRINT AT 1,12;"TIME
     UP"
200 PRINT AT 3,12;"SCORE:";PEEK
     16522+256*PEEK 16523
210 IF INKEY$<>"" THEN GOTO 210
220 IF INKEY$="" THEN GOTO 220
230 GOTO 160
240 SAVE "TURBO"
250 RUN
```

Corridors of fear

Colin Carruthers,
Edinburgh.

SPECTRUM

THE THREE-DIMENSIONAL view that confronts you when you play this game shows the corridors within a maze from which you must escape within a given time. Your current x-y co-ordinate is displayed along with your orientation and the x-y co-ordinate of the way out.

Movement around the maze is by means of the cursor control keys: 7 moves one space forward — unless there is a wall directly in front — and 5 and 8 turn the player through 90° to the left or right.

At the end of the game, a plan of the maze is drawn so the player can see where he took the wrong turning. The game consists of a short machine-code routine and a larger Basic program.

The machine-code routine clears the first 22 columns of the display file and is best entered using the short Basic program. Run it, save it on tape and test the routine by typing

LET x=USR 23760

Assuming all is well, delete lines 10-40 by typing their line numbers. Type in the main program, using:

LIST 2

instead of just List to avoid listing the machine-code. The graphics characters in line 5025 are graphic ABCD and the inverse characters in 5786 say "Hit any key to being".

Each maze used in random, generated from four out of eight possible segments, each five by five units giving a final maze of 10 by 10 units.

```
   1 REM aaaaaaaaaaaaaaaaaaaaaaaa
aaaaaaaaa
  10 DATA 6,192,17,10,0,33,0,64,
197,6,22,54,0,36,16,251,237,90,1
93,16,243,201
  20 FOR x=23760 TO 23781
  30 READ v: POKE x,v
  40 NEXT x
  5>RANDOMIZE : BORDER 0: PAPER
0: INK 7
  10 CLS : PRINT AT 5,7;"M A Z E
";AT 10,2;"© Colin Carruthers";A
T 12,8;"1983"
  20 GO SUB 5000
  45 GO SUB 3000: PRINT AT 21,23
;d$(f)
  50 GO SUB 1000
  60 LET z$=INKEY$
  61 LET t=INT ((256*PEEK 23673+
PEEK 23672)/50)
  62 INK 0: PLOT 240,tiee-t+8: D
RAW 7,0: DRAW 0,1: DRAW -7,0: DR
AW 0,1: DRAW 7,0: INK 7
  63 IF t>atime THEN LET z$="TIM
E UP !" FOR e=10 TO -15 STEP -2
: BEEP .2,e: NEXT e: GO TO 7000
  64 IF z$<"5" AND z$<>"8" AND
z$<>"7" THEN GO TO 60
  65 IF z$="7" THEN LET xp=xp+(x
a AND a$(xp,yp)(1)<>"w")
  66 IF xp>xmax OR xp<1 THEN LET
q$="FREE !": GO TO 7000
  67 IF z$="7" THEN LET yp=yp+(y
a AND a$(xp,yp)(1)<>"w")
  68 IF yp>ymax OR yp<1 THEN LET
q$="FREE !": GO TO 7000
  70 IF z$="5" THEN GO SUB 4000
  80 IF z$="8" THEN GO SUB 4100
  85 GO SUB 3000: PRINT AT 21,23
;d$(f)
  90 GO TO 50
1000 LET x=xp: LET y=yp: LET dro
p=2000
1015 GO SUB 3000
1019 LET q=USR 23760: PRINT AT 2
1,9;xp;",";yp
```

(continued on next page)

(continued from previous page)

```
1020 IF m$(x,y)="w" THEN GO S
UB draw : GO TO 1030
1025 IF m$(x,y)="e" THEN GO T
O 1030
1025 IF m$(x-ya,y+xa)="w" THE
N GO SUB draw+30
1030 IF m$(x,y)="w" THEN GO S
UB draw+10: GO TO 1040
1032 IF m$(x,y)="e" THEN GO T
O 1040
1035 IF m$(x+ya,y-xa)="w" THE
N GO SUB draw+40
1040 IF m$(x,y)="w" THEN GO S
UB draw+20: RETURN
1045 IF m$(x,y)="e" THEN RETU
RN
1050 LET x=x+xa: LET y=y+ya: LET
 draw=draw+100: GO TO 1020
2000 PLOT 0,175: DRAW 24,-24: DR
AW 0,-127: DRAW -24,-24: RETURN
2010 PLOT 175,175: DRAW -24,-24:
DRAW 0,-127: DRAW 24,-24: RETUR
N
2020 PLOT 24,151: DRAW 127,0
2021 DRAW 0,-127: DRAW -127,0
2022 DRAW 0,127
2023 RETURN
2030 PLOT 0,151: DRAW 24,0: DRAW
 0,-127: DRAW -24,0
2035 RETURN
2040 PLOT 175,151: DRAW -24,0: D
RAW 0,-127: DRAW 24,0: RETURN
2100 PLOT 24,151: DRAW 24,-24: D
RAW 0,-79: DRAW -24,-24
2101 DRAW 0,127: RETURN
2110 PLOT 151,151: DRAW -24,-24:
DRAW 0,-79: DRAW 24,-24
2111 DRAW 0,127: RETURN
2120 PLOT 48,127: DRAW 79,0: DRA
W 0,-79: DRAW -79,0: DRAW 0,79
2125 RETURN
2130 PLOT 24,127: DRAW 24,0: DRA
W 0,-79: DRAW -24,0: RETURN
2140 PLOT 151,127: DRAW -24,0: D
RAW 0,-79: DRAW 24,0: RETURN
2200 PLOT 48,127: DRAW 16,-16: D
RAW 0,-47: DRAW -16,-16: DRAW 0,
79: RETURN
2210 PLOT 127,127: DRAW -16,-16:
DRAW 0,-47: DRAW 16,-16: DRAW 0
,79: RETURN
2220 PLOT 64,111: DRAW 47,0
2221 DRAW 0,-47: DRAW -47,0: DRA
W 0,47
2225 RETURN
2230 PLOT 48,111: DRAW 16,0: DRA
W 0,-47: DRAW -16,0
2231 RETURN
2240 PLOT 127,111: DRAW -16,0: D
RAW 0,-47: DRAW 16,0
2241 RETURN
2300 PLOT 64,111: DRAW 11,-11: D
RAW 0,-25: DRAW -11,-11: DRAW 0,
47: RETURN
2310 PLOT 111,111: DRAW -11,-11:
DRAW 0,-25: DRAW 11,-11: DRAW 0
,47: RETURN
2320 PLOT 75,100: DRAW 25,0: DRA
W 0,-25: DRAW -25,0: DRAW 0,25
2325 RETURN
2330 PLOT 64,100: DRAW 11,0: DRA
W 0,-25: DRAW -11,0: RETURN
2340 PLOT 111,100: DRAW -11,0: D
RAW 0,-25: DRAW 11,0: RETURN
2400 PLOT 75,100: DRAW 7,-7: DRA
W 0,-11: DRAW -7,-7: DRAW 0,25:
RETURN
2410 PLOT 100,100: DRAW -7,-7: D
RAW 0,-11: DRAW 7,-7: DRAW 0,25:
RETURN
2420 PLOT 62,93: DRAW 11,0: DRAW
 0,-11: DRAW -11,0: DRAW 0,11
2421 RETURN
2430 PLOT 75,93: DRAW 7,0: DRAW
0,-11: DRAW -7,0: RETURN
2440 PLOT 100,93: DRAW -7,0: DRA
W 0,-11: DRAW 7,0: RETURN
2500 PLOT 82,93: DRAW 4,-4: DRAW
 0,-3: DRAW -4,-4: DRAW 0,11
2501 RETURN
2510 PLOT 93,93: DRAW -4,-4: DRA
W 0,-3: DRAW 4,-4: DRAW 0,11
2511 RETURN
2520 PLOT 86,69: DRAW 3,0: DRAW
0,-3: DRAW -3,0: DRAW 0,3
2521 RETURN
2530 PLOT 82,69: DRAW 4,0: DRAW
0,-3: DRAW -4,0: RETURN
2540 PLOT 93,69: DRAW -4,0: DRAW
 0,-3: DRAW 4,0: RETURN
3000 IF ya=1 THEN LET f=1: LET l
=2: LET r=4: RETURN
3020 IF ya=-1 THEN LET f=4: LET
l=3: LET r=2: RETURN
3030 IF xa=1 THEN LET f=3: LET l
=1: LET r=4: RETURN
3040 LET f=2: LET l=4: LET r=1:
RETURN
4000 IF ya=-1 THEN LET xa=0: LET
 ya=1: RETURN
4020 IF ya=1 THEN LET ya=0: LET
xa=-1: RETURN
4030 IF xa=1 THEN LET xa=0: LET
ya=1: RETURN
4040 LET xa=0: LET ya=-1: RETURN
4100 IF ya=-1 THEN LET ya=0: LET
 xa=-1: RETURN
4120 IF ya=1 THEN LET ya=0: LET
xa=1: RETURN
4130 IF xa=1 THEN LET xa=0: LET
ya=-1: RETURN
4140 LET xa=0: LET ya=1: RETURN
5000 DIM m$(10,10,4): LET x=m$(x
0): LET y=m$(x+10)
5005 PAPER 4: INK 7: CLS
5010 POKE USR "a",255: POKE USR
"a"+7,255
5015 FOR x=1 TO 7: POKE USR "a"+
x,0: POKE USR "a"+8-x,0: NEXT x
5020 FOR x=0 TO 7: POKE USR "b"+
x,128: POKE USR "c"+x,1: NEXT x
5025 DIM s$(4): LET s$="]"
5100 PLOT 239,0: DRAW 0,0: DRAW
0,161: DRAW -9,0: DRAW 0,-161
5200 FOR x=20 TO 1 STEP -1: PRIN
T AT x,30; PAPER 4; INK 7; BEEP .01
,20-x: NEXT x
5205 PRINT AT 20,25;"time"
5300 LET xa=1: LET ya=0
5700 LET yg=10: LET x=1: LET z=
(RND).49)*100: RESTORE 6000+z: G
O SUB 5800
5710 LET xa=6: LET z=(RND).49)*1
00: RESTORE 6200+z: GO SUB 5800
5720 LET ya=5: LET xg=1: LET z=(
RND).49)*100: RESTORE 6400+z: GO
 SUB 5800
5730 LET xa=6: LET z=(RND).49)*1
00: RESTORE 6600+z: GO SUB 5800
5735 LET z=RND
5740 LET yg=1+(z(.33)*10+(z).67)
5745 IF NOT ye THEN LET ye=INT (
RND*10)+1
5750 IF ye=1 OR ye=10 THEN LET x
=INT (RND*10)+1: GO TO 5770
5760 LET xe=1+(9*(RND).49))
5770 IF xe=1 THEN LET m$(xe,ye)(
31)="e": GO TO 5780
5772 IF xe=10 THEN LET m$(xe,ye)
(31)="e": GO TO 5780
5774 IF ye=1 THEN LET m$(xe,ye)(
41)="e": GO TO 5780
5776 LET m$(xe,ye)(1)="e"
5785 LET xp=11-xe: LET yp=11-ye
5786 LET sx=xp: LET sy=yp: BEEP
.2,0: PRINT AT 21,0;"[redacted]
5787 PRINT AT 0,25;"EXIT"; AT 4,2
5788 PRINT AT 1,23;"s";"y";
5790 LET t$="1333": LET t=0: POKE
 23674,0: POKE 23675,0: POKE 236
76,0
5795 PRINT AT 1,30; INK 4;"m"
5799 RETURN
5800 FOR y=yg TO yg-4 STEP -1
5810 READ z$
5820 FOR x=1 TO 5
5830 LET m$(x+xa-1,y)=z$(4*x-3 T
O 4*x)
5840 NEXT x: NEXT y
5850 RETURN
5900 OVER 1
5920 FOR y=ya TO 1 STEP -1: FO
R x=1 TO xa: FOR d=1 TO 4
5930 IF m$(x,y)(d)="w" THEN PRIN
T AT 15-y,x+4,s$(d)
5935 NEXT d
5936 IF y=ya AND y=yg THEN PRINT
5937 IF y=xa AND y=yp THEN PRINT
AT 15-y,x+4,s$(1)
5940 NEXT x: NEXT y
5950 OVER 0
5970 RETURN
7000 IF q$(1)="P" THEN BEEP .5,1
0: BEEP .5,15
7005 LET a=USR 23760: PRINT AT 1
,9; INVERSE 1;a$
7010 GO SUB 5788
7012 PRINT AT 17,3;"* = start po
sition"
7015 PAUSE 100: BEEP .2,-7: BEEP
.4,0
7020 PRINT AT 21,0;"Another Go ?
(Y/N)"
7030 IF INKEY$="n" OR INKEY$="N"
THEN STOP
7035 IF INKEY$="y" OR INKEY$="Y"
THEN RUN
7040 GO TO 7030
9000 DATA "ww  w www ww w  ww  "
9010 DATA "ww ww ww  w  w  w  w"
9020 DATA "  w ww w  w  w  w  w"
9040 DATA "  w ww w  w  w  w  w"
9050 DATA "  ww ww w  w  ww  w"
9100 DATA "www ww ww  w  ww  w"
9110 DATA "  w  w  w ww  w  w"
9120 DATA "ww  ww  w  w  w  w"
9130 DATA "  w  w  w  w  w  w"
9140 DATA "  ww  w  w  w  ww  "
9200 DATA "www  w www  w  w  w"
9210 DATA "www  w  w  w  w  w"
9220 DATA "www  w  w  w  w  w"
9230 DATA "  w  w  w  w  w  w"
9300 DATA "w  ww www  w  w  w"
9310 DATA "w  w  w  w  w  w  w"
9320 DATA "  ww  w  w  w  w  w"
9330 DATA "  w  w  w  w  w  w"
9340 DATA "  w  w  w  w  w  w"
9400 DATA "  w ww  w  wwww
```

```
200 F=F+1:G=G+3
210 PSET(F,G,6)
220 PSET (X,Y,6):PSET(X1,Y1,6)
230 IF SCORE>60 THEN 240 ELSE260
240 T=T+1:Q=Q+4
250 PSET(T,Q,6)
260 IF Y=151 OR Y1=151 THEN 60
270 IF X1<4 THEN X1=X1 +2
280 IF G=150 THEN BASE=BASE+1
290 IF G=153 THEN 60
300 IF Q=148 THEN BASE=BASE+1
310 IF Q=152 THEN 60
320 IF A=1 THEN X1=X1+2
330 IF A=2 THEN X=X-2
340 J=JOYSTK(0):JJ=JOYSTK(1)
350 PRESET(X2,Y2)
360 P=PEEK(65280)
370 PRESET(F,G):PRESET(T,Q)
380 IFJ<10 THEN X2=X2-3
390 IFJ>50 THEN X2=X2+3
400 IF JJ>50 THEN Y2=Y2+3
410 IF JJ<10 THEN Y2=Y2-3
420 IF Y2=>145 THEN Y2=Y2-3
430 IF X2=<3 THEN X2=X2+3
440 IF X2=3 THEN PSET(X2,Y2,5)
450 IF Y2=145 THEN PSET(X2,Y2,5)
460 IF Y2=<3 THEN Y2=Y2+3
470 IF Y2=3 THEN PSET(X2,Y2,5)
480 PSET(X2,Y2,7)
490 IF BASE>=1 THEN PSET(44,174,7)
500 IF BASE >=2 THEN PSET(85,174,7)
510 IF BASE  >=3 THEN PSET(168,174,7)
520 IF BASE  >=4 THEN PSET(216,174,7)
530 IF BASE=4 THEN GOTO 730
540   IF P=126 THEN 550 ELSE 690
550 FOR R=1 TO I+2
560 CIRCLE (X2,Y2),R,7
570 NEXT R
580 IF PPOINT(X,Y)=7 THEN SOUND 5,10:IF PPOINT (X,Y)=7 THEN Y=0:
IF PPOINT(X,Y)=7 THEN SCORE=SCORE+5
590 IF PPOINT(F,G)=7 OR PPOINT(T,Q)=7 THEN SCORE =SCORE+10
600 IF PPOINT(F,G)=7 OR PPOINT(T,Q)=7 THEN SOUND 15,1
610 IF PPOINT(T,Q)=7 THEN T=128:IF T=128 THEN Q=0
620 IF PPOINT(F,G)=7 THEN F=33: IF F=33 THEN G=0
630 IF PPOINT(X1,Y1)=7 THEN SCORE=SCORE+5
640 IF PPOINT(X1,Y1)=7 THEN SOUND 22,10
650 IF PPOINT (X1,Y1)=7 THEN Y1=0
660 FOR Q= 1 TO I+2
670 CIRCLE(X2,Y2),Q,5
680 NEXT Q
690 IF PPOINT(X,Y)=8 OR PPOINT(X1,Y1)=8 THEN BASE=BASE+1
700 GOTO 160
710 FOR D=1 TO  5:                    C=RND(8)
720 CLSC:SOUND D,3:NEXT D
730 CLS4:PRINT@12,"end of game";
740 PRINT@44,"SCORE=";SCORE;
750 PRINT@290,"ANOTHER(Y OR N)";:INPUT A$
760 IF A$="Y" THEN RUN:END
```

Tank killer

Peter Wales,
Hereford.

VIC-20

USING MULTICOLOUR mode graphics on the unexpanded Vic-20, you can create this bombing game. The objective is to blow up a tank by dropping a bomb from your supersonic jet while avoiding the tank's return of fire. There are 10 skill levels in the game. These determine the rate at which the tank's missiles home in on you and the speed of the tank.

To obtain multicolour graphics for text, Poke 646,12 then use Print. To use this mode for graphics, Poke the colour memory map with 12 for the position of your object. To achieve horizontal bars in the graphics use Poke 36878,16. To turn them off use Poke 36878,0. This is the volume location. This is used to flash the plane and create good graphic explosions in the game.

Main program lines

10 - 80	INITIALISATION
300 - 395	MAIN SUBROUTINE
5000 - 5090	YOUR SHOT ROUTINE
8000 - 8135	YOUR WIN ROUTINE
8140 - 8440	TITLE INSTRUCTIONS
9000 - 9080	ROUTINE TO ANIMATE TANK
9910 - 9970	TANK-SHOOTING ROUTINE
10000 - 10100	YOU LOSE ROUTINE
30000 - 30060	SKILL LEVEL ROUTINE

Main variables

P	=	POSITION OF JET
TB	=	POSITION OF TANK
M	=	POSITION OF BOMB
TM	=	POSITION OF MISSILE
SN	=	SOUND LOCATION
VN	=	VOLUME, GRAPHICS LOCATION
SK	=	SKILL LEVEL
G$	=	TIME
A$	=	KEYBOARD INPUT

To make the game more difficult change line 5075 to:

5075 IF PEEK (H + 22 + I) = 30 THEN 8000

Now you have to hit the tank in the dead centre.

```
3 REM *(C) PETER WALES *
4 REM *  A TWO TONE   *
5 REM *  GRAPHICS GAME *
6 REM ******************
10 PRINT"□#";CHR$(8) POKE36879,14 POKE36878,15 POKE650,255 POKE196,0 N1#="999999
"
20 FORN=8186TO8230 POKEN,32 NEXT VN=36878 SN=36874
30 GOTO8140
40 TI$="000000":POKE646,10 PRINT"□" TB=INT(RND(1)*18)
50 P=7680+40
300 REM
301 POKEVN,FL POKESN,F/35
302 FL=16-FL GETA$
320 IFA$="W"THENP=P-22
330 IFA$="Z"THENP=P+22
333 IFC7702THENP=P+22
334 IFP9801THENP=P-22
340 IFA$="P"ANDF=0THEN005UB5000 GOTO355
341 PRINT"■"TIME ■";TI$
345 IFF=1THEN005UB5000
346 GOSUB9000
355 CP=38400+P-7680
356 POKECP-12:POKECP-1,10:POKECP-2,10:POKECP-24,10:POKECP+20,10
360 POKEP,62:POKEP-1,60:POKEP-2,35:POKEP-24,77:POKEP+20,78
390 POKEP-3,32:POKEP-25,32:POKEP+19,32:POKEP+41,32:POKEP-47,32:POKEP+21,32:POKEP
-23,32
```

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```
391 IFTF=1THENIFPEEK(TM)<>32THEN10000
395 P=P+1:POKEVM,0 GOTO300
5000 IFF=1THEN5030
5010 IFF=0THENF=1:H=P
5030 POKEM,PX:POKEH+30400-7680,12:POKEH-22-1,32:POKEH-23-1,32
5031 H=H-22-1:IFH>7680+20THENH=H-22 I=0 GOTO5037
5035 IFH<7680+20THENH=H+15 I=1.5 GOTO5037
5036 PX=4 I=1
5037 REM
5070 IFH<8108THENF=0:POKEH-22-1,32
5075 IFPEEK(H+1)<32THEN8000
5090 RETURN
8000 G=T1# FORP=1TO12 FORH=1TO14:POKE36879,N NEXTN,P
8001 POKE646,14 PRINT"XXXXXXXXXXXXXXXXXXXX";TAB(T8);"♦♦♦♦♦♦♦♦♦♦♦♦♦"
8005 POKEH-22,32
8006 F=0 TF=0
8010 FORH=130TO240:POKEH,N FORV=20TO8STEP-2 POKEVN,V
8020 NEXTV,N
8030 PRINT"□" POKE646,14
8040 PRINT"WELL DONE "
8050 PRINT"XXXIN ";G#;" SECONDS"
8060 FORH=1TO10
8070 POKEVN,19 FORT=1TO150:NEXT
8080 POKEVN,0 FORT=1TO100 NEXT
8090 NEXT
8100 PRINT"XXXWELL DONE "
8110 PRINT"XXXIN ";G#;" SECONDS"
8120 FORT=1TO1000:NEXT
8130 IFG#<H1#THENPRINT"XXXTHAT WAS A GOOD RUN" H1#=G#
8135 FORT=1TO2000:NEXT
8140 S#="XXXXXXXXXXXX"
8141 PRINT"□H# S              "
8142 PRINT"    S   BOMB RUN#    "
8143 PRINT"    S              "
8144 PRINT"XX   BEST TIME #";H1# PRINT"XC) PETER WALES 1982"T$
8145 POKE646,14
8147 F=0 TF=0
8200 PRINT"XXXXXXXXYOU MUST BOMB THE TANK" PRINT"USING YOUR SUPER JET."
8210 PRINT"YOU MAY ONLY DROP ONE BOMB AT A TIME." PRINT"XWATCH OUT FOR THE TRA
K";
8220 PRINT"IT SHOOTS TOO!"
8230 PRINT"  XXTWUPB ZA-Z=DOWN@ @#F=FIRE@" POKE646,12
8250 FORP=8TO17
8260 PRINT#1,TAB(A);"\"
8270 PRINTTAB(A);"#<>"
8280 PRINTTAB(A);"/"
8290 FORH=1TO100 POKEVN,0 POKEVN,16 GETA#:IFA#="T"THENNEXTN:NEXTA
8300 PRINT"□#";
8400 PRINT"XXXWOULD YOU LIKE TO PLAY" PRINT"XXXXXXXXBOMB RUN"
8405 PRINT"XX   S   S Y N N "
8410 GETA# IFA#="Y"THEN9410
8420 IFA#="Y"ORA#="T"THEN30000
8430 IFA#="N"THENPRINT"XOK BYE.BYE." END
8435 GOTO9410
8440 END
8999 REM TANK
9000 POKE646,12 PRINT"XXXXXXXXXXXXXXXXXXXX";TAB(T8);"/\ ";"XXXXXX ♦♦♦ "
9010 TT=P-7680:TD=INT((P-7680)/22):TA=TT-(TD*22)
9015 POKEVN,15 POKESN,128+(4*TD)
9020 IFTB<TA THENTB=TB+SK:TM=TM+SK
9025 IFTB>TA THENTB=TB-SK:TM=TM-SK
9035 POKESN,0
9040 IFTB<8THENTB=18
9050 IFTB>18THENTB=8 PRINT"XXXXXXXXXXXXXXXXXXXX";TA$(17);"     XXXXXX     "
9060 IFTF=1THEN9910
9070 IFTF=0ANDRND(1)>.6THEN9910
9080 RETURN
9910 IFTF=0THENTF=1:TM=8100+TB
9915 POKETM,30 POKETM+30720,14
9920 TM=TM-22
9950 IFTM<7782THENTF=0 POKETM+22,32:REMPOKETM-21,32:POKETM-23,32
9960 POKETM+44,32:POKETM+43,32:POKETM+45,32
9970 GOTO9800
10000 FORH=220TO128STEP-2
10005 POKE36879,N-116
10010 POKESN,N
10020 FORV=1TO20 POKEVN,V NEXT
10030 NEXTN
10040 PRINT"XXXXXXXXXXXXXXXXXXXX";
10050 PRINT"XXXXXXXYOU GOT HIT!"
10060 PRINT"XXXXXXXXXTIME M .T1#
10070 POKEVN,0 POKESN,0
10080 PRINT"XXXX  PRESS A KEY"
10085 POKE198,0
10090 WAIT198,1 GETA#
10100 GOTO8141
30000 PRINT"□H   H BOMB RUN H"
30010 PRINT"XXX  WHAT SKILL LEVEL" PRINT"XXX  (0 TO 10) EASY-HARD"
30030 PRINT"XH: INPUTA
30040 IFA<0ORA>10THEN30000
30045 SK=INT(A)/10
30060 GOTO40
```

Psychic asteroids

J P Riggs,
Gosport,
Hampshire.

BBC

WRITING GAMES on a home computer can pose many problems, the main one being where do I start? You can start designing things like the layout of the screen, special characters and sound effects. If the game is of the type where you are playing the computer the program must contain the logic to handle this. Once the program has been written you will want to improve it by speeding it up and having better presentation and a more exciting game.

In this program the ship can be rotated and the relevant positions must be calculated many times a second to give the effect of the craft spinning, therefore sine and cosine tables are set up before the games commences. Other ways of speeding up are a program to remove any routines which are wasting time, spaces and superfluous text. Simplifying the equations before the computer evaluates them can save a great deal of time.

If you have moving graphics you need them to move smoothly across the screen without disturbing features such as the scores and visual information. This can be achieved on the BBC by setting up separate graphics and text windows, using VDU24 for graphics window and VDU28 for text windows — see page 386 of the manual.

To make the game more exciting, better graphics and sounds can be developed. The graphics are fairly easy to achieve using the wide variety of commands such as Move, Draw and Plot available on the BBC. The sounds are not so easy to create because the Envelope command takes time to master. The sounds in this program were created using the Envelope-defining program published in the November 1982 issue of *Your Computer.*

The program is a space asteroids game with a difference. Where normal asteroids just amble across the screen these contain homing devices and high explosives. Just dodging them is not enough: you have to blow them out of the ether using quick reflexes and your laser cannon. Your craft can be moved through 360° and propelled using the thruster.

The control keys are: F0 left turn; F1 right turn; F2 a quick 180° turn; F3, F4, F5 hyperspace; F6 thrust; F7 fire.

```
>L.
   1 REM BY J.P.RIGGS 1983
   2 REM   GOSPORT,HANTS
  10 ONERROR RUN
  20 MODE7:PROCoff:*FX16,0
  30 DIMSI(90),CO(90):FORAZ=0TO360STEP4:PRINTTAB(12,12):INT((360-AZ)/36);" ";:S
I(AZ/4)=SINRAD(AZ):CO(AZ/4)=COSRAD(AZ):NEXTAZ
  40 *KEY10"OLD:MRUN:M"
  50 PROCoff:VDU23,224,24,24,60,60,126,126,231,231,23,225,60,69,153,165,165,153
,69,60:NU$=" "+CHR$224:*FX16,0
  60 PRINTCHR$12:TAB(0,0):STRING$(40,"="):TAB(0,1)"* P S Y C H I C       A S T E
R O I D S *":TAB(0,2):STRING$(40,"="):*FX15,0
  70 PRINT''''Do you want background noises (Y/N) ";ggg=GET:*FX9,5
  80 ONERROR GOTO160
  90 ENVELOPE1,1,-10,10,100,200,10,200,120,-100,-4,-1,120,127:*FX10,5
 100 FORX=100TO128:SOUND1,1,X,1:SOUND2,1,(255-X),1:NEXTX:X=INKEY(20)
 110 HIGHSCORE=55e:HIGHSCORER$="J.RIGGS":A$=" ":HS=55e:MF=1.5
 120 ENVELOPE1,0,-8,-3,122,227,245,194,123,-76,-1,-6,126,126:ENVELOPE2,129,2,4,
6,20,14,7,0,0,0,-80,80,80
 130 ENVELOPE4,1,1,2,0,0,123,1,-110,0,-1,-20,125,70:ENVELOPE3,1,12,1,3,1,2,12,-
1,1,-1,-1,126,126
 140 XXX=RND(90)*4:STX=640:RTX=512:A$="W":YOX=RTX:XIX=STX
 150 SCORE=0:NOLEFT=3:JJX=20:PROCastinit:*TV255,2
 160 MODE4:VDU19,0,1,0,0,0:PROCscore:PROCcalc:PROCstars(400):PROCdraw
 170 VDU24,&00,&00,&00,&00,&FF,&04,&BA,&03
 180 REPEAT PROCcontrol:PROCasteroid:UNTIL NOLEFT<=0:PROCend:GOTO140
 190 DEFPROCcontrol:REM Change 723& TO 7215 AND DELETE BX=7237 and ORBX= for 0S
0.1
 200 AX=723&:BX=7237:IFAX=160 OR BX=160:XXX=XXX+8*RND(2):PROCdraw:PROCtest(aX,b
X,c):IF RND(3)=1 GOTO200
 210 AX=723&:IFAX=241 OR BX=241:XXX=XXX-8*RND(2):PROCdraw:PROCtest(aX,bX,c):IF
RND(3)=1 GOTO210
 220 IFAX=242 ORBX=242 XXX=XXX+180:PROCdraw:PROCtest(aX,bX,c):PROCasteroid
 230 IFAX=245 ORBX=245:PROCdistance:IF JJX>(25*c) PROCthrust(70):PROCasteroid
 240 IFAX=148 OR AX=243 OR AX=244 A$="HYPERSPACE":PROCdraw:PROCtest(aX,bX,c)
 250 IFAX=148 OR AX=243 OR AX=244:IF RND(3)=1 NOLEFT=NOLEFT-1:VDU7:PROCscore
 260 IFAX=150 ORBX=150 AND RND(1)>0.35 PROCdistance:IF JJX>40PROCfire:PROCaster
oid
 270 ENDPROC
 280 DEFPROCcalc:XXX=(360+(XXX<0)*ABS(XXX)-(XXX>0)*ABS(XXX)) MOD 360:X1=(XXX+18
0) MOD 360:X2=(XXX+215) MOD 360:X3=(XXX+145) MOD 360
 290 IF RTX>945 RTX=5:STX=(1280-STX) ELSE IF RTX<0 RTX=940:STX=(1280-STX):GOTO3
10
 300 IF STX>1280 STX=5:RTX=(1024-RTX) ELSE IF STX<0 STX=1275:RTX=(1024-RTX)
 310 YX=SI(XXX/4)*38+RTX:YOX=SI((X3)/4)*42+RTX:YTX=SI((X2)/4)*42+RTX
 320 XOX=CO(XXX/4)*38+STX:XIX=CO((X3)/4)*42+STX:XTX=CO((X2)/4)*42+STX
```

(continued on page 129)

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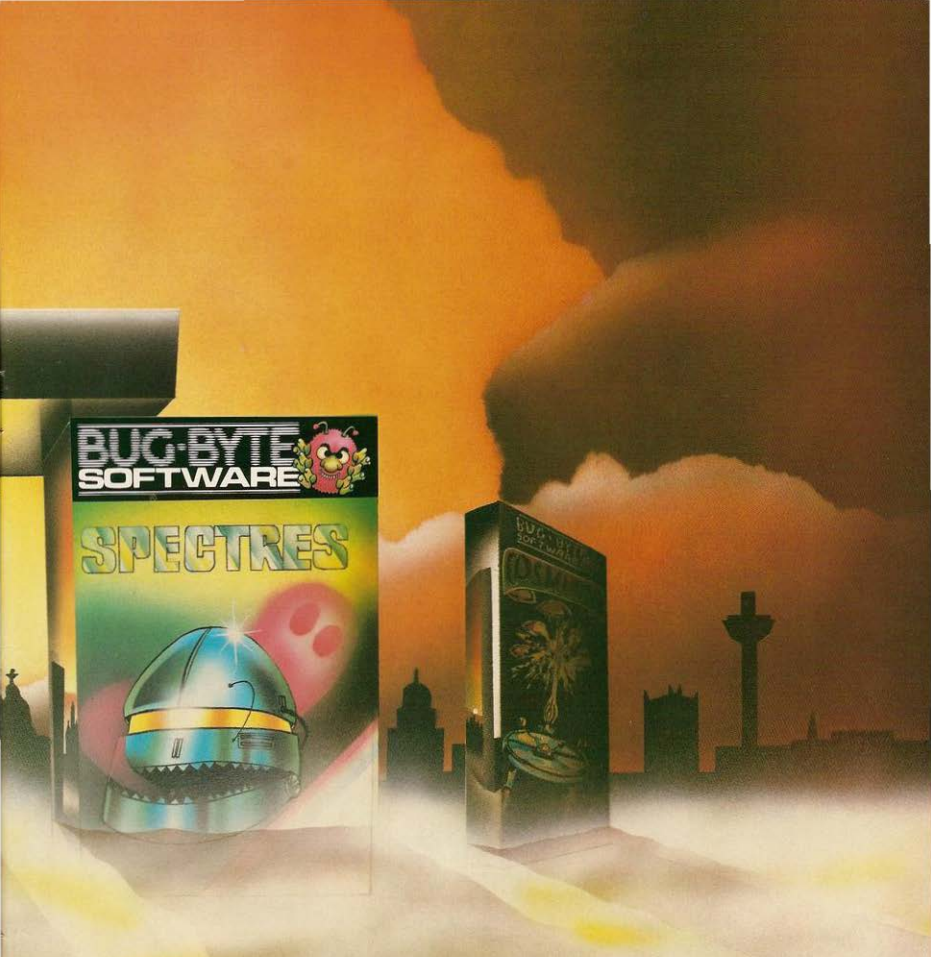
Then suddenly it happened. First one, then another, then tens, hundreds, thousands of tired screens felt a surge of power and flickered back into life. They were much as I had seen on my own planet's microcomputers – the ZX 81, ZX Spectrum, Vic 20, BBC Micro and ORIC-1.

The minds paused to take stock. They clustered round the screens, their nimble fingers excitedly flicking the controls back and forth. At last they had found a challenge . . . action and adventure with cunning tests of dexterity and reaction. Everywhere, conversation was of Asteroids, Mazogs, Panic, Another Vic in the Wall.

Unable to resist, I too had a closer look. There before me was vivid colour, high resolution graphics. I could practically feel the spine-tingling



...IT'S A DOOR TO ANOTHER DIMENSION !

sound effects as whole battle fleets of Cosmiads swarmed out of nowhere and attacked. I should have known. As my fingers raced over the controls, and I prepared to stand and fight with only a single laser bolt for protection, I realised I was trapped!

Too late now, I remembered this was no ordinary software. I'd been warned, as I now warn anyone buying from Laskys, W.H. Smith, Currys Micro C, Spectrum and larger branches of Boots, and a nationwide network of dealers stocking Bug-Byte. Because Bug-Byte is more than a game, it's a door to another dimension. One that I had opened.

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(continued from page 124)

```
330 CXX=CO((X1)/4)*11+STX:CYX=SI((X1)/4)*11+RTX:ENDPROC
340 DEFPROCdraw:IF RND(3)=1 AND A$<>"HYPERSPACE" PROCasteroid
350 MOVEXO%,Y%:PLOT7,X1%,YO%:PLOT7,CX%,CY%:PLOT7,XTX,YTX:PLOT7,XO%,Y%
360 IF A$="HYPERSPACE" RTX=RND(950):STX=RND(1280):XX%=RND(360)
370 A$="x":PROCcalc:MOVEXO%,Y%:DRAWX1%,YO%:DRAWCX%,CY%:DRAWXTX,Y%:DRAWXO%,Y%:
ENDPROC
380 DEFPROCthrust(BO%):SOUND0,-15,100,8:RTX=RTX+SI(XXX/4)*BO%:STX=STX+CO(XXX/4
)*BO%:PROCdraw:ENDPROC
390 DEFPROCfire:SOUND1,1,1,10:VDU5
400 FY%=YX+SI(XXX/4)*JJX:FX%=CO(XXX/4)*JJX+XO%
410 FORMN=0TO1:GCOL0,1:MOVEXO%,Y%:DRAWFX%,FY%:PLOT0,0,16:PRINTCHR$225
420   GCOL0,0:MOVEXO%,Y%:DRAWFX%,FY%:PLOT0,0,16:PRINTCHR$225
430   NEXT:VDU4:PROCoff:GCOL0,1:IF SQR((FX%-aX)^2+(FY%-bX)^2)<25*c PROCastdest
440 ENDPROC
450 DEFPROCasteroid:IF RND(3)=1 PROCdiff
460 IF ggg=89 AND RND(4)=1 SOUNDRND(3),3,RND(255),2
470 PROCtest2:aX=aX+KTX:bX=bX+JTX:c=c*MF:MF=1/MF:MOVE(aX-10*c),(bX-10*c)
480 DRAW(aX+20*c),(bX-5*c):DRAW(aX+25*c),(bX+25*c):DRAW(aX+5*c),(bX+30*c)
490 DRAW(aX-10*c),(bX-10*c):PROCtest(aX,bX,c)
500 IFaX>1280 OR bX>1024 OR aX<0 OR bX<0 PROCtest2:PROCastinit
510 ENDPROC
520 DEFPROCstars(ND)
530 FORX=0TO ND:JZ=RND(1280):KZ=RND(1024):MOVEJZ,KZ:PLOT69,JZ,KZ:NEXT:ENDPROC
540 DEFPROCscore:PROCoff:IFSCORE>HS HS=SCORE
550 IF NOLEFT<0 ENDPROC
560 PRINTCHR$30;" SCORE=";SCORE;"     HIGH SCORE=";HS;TAB(25,1);STRING$(NOLEFT,
NU$);" "
570 ENDPROC
580 DEFPROCdestroy:VDU19,0,0,0,0,0,0:NOLEFT=NOLEFT-1:PROCscore:*FX15,0
590 SOUND0,-15,5,50:FORSZ=1TO5:FORXPRZ=1TO20 STEP2:D=INKEY(2):VDU23;13,XPRZ,0;
0;0;:NEXT:FORXPRZ=20 TO0STEP-2:D=INKEY(2):VDU23;13,XPRZ,0;0;0;:NEXT,A$="HYPERSP
ACE":PROCdraw:SOUND0,-15,6,12:A$="":VDU19,0,1,0,0,0:ENDPROC
600   DEFPROCend:SOUND2,0,0,0
610   VDU5:MOVE352,525:PRINT"G A M E   O¼V E R":VDU4:*FX15,0
620   OO=INKEY(1000):*FX15,0
630   VDU22,7:PRINT'''''"Your score is ";SCORE;" points"''
640   PRINT"High score is ";HIGHSCORE;" points by";CHR$129:HIGHSCORER$''
650   IF SCORE>HIGHSCORE HIGHSCORE=SCORE:PRINT"Yours is the highest score":IN
PUT"Please enter initials ",HIGHSCORER$''
660   HIGHSCORER$=LEFT$(HIGHSCORER$,4):INPUT"PRESS RETURN"A:HS=HIGHSCORE:ENDPR
OC
670   DEFPROCastinit:RANDOM=RND(-TIME)
680   c=(RND(30)+10)*(3E-2)
690   REPEAT:PosX=RND(4):aX=RND(1280)*(-1)*(PosX=2 OR PosX=4)-1280*(PosX=3)
700    bX=RND(9A0)*(-1)*(PosX=1 OR PosX=3)-950*(PosX=2):UNTILABS(STX-aX)>40
710   PROCdiff:ENDPROC
720   DEFPROCdiff:DIFFx%=(STX-aX):DIFFy%=(RTX-bX):IFDIFFy%=0 OR DIFFx%=0 ENDPR
OC
730   DX=DIFFx%/ABS(DIFFx%):DY=DIFFy%/ABS(DIFFy%)
740   IF ABS(DIFFx%)>20 KTX=(RND(5)+B)*DX:JTX=DIFFy%/DIFFx%*KTX:ENDPROC
750   IF ABS(DIFFy%)>20 JTX=(RND(5)+B)*DY:KTX=DIFFx%/DIFFy%*JTX:ENDPROC
760   KTX=10*DX:JTX=10*DY:ENDPROC
770   DEFPROCastdest:PROCtest2:SC=INT((SCORE+150-INT(50*c))/10)*10
780   PROCextra:SCORE=SC:PROCscore:PROCexplosion(aX,bX,65,2.2):PROCastinit:PRO
Casteroid:ENDPROC
790   DEFPROCtest2:MOVE(aX-10*c),(bX-10*c):PLOT7,(aX+20*c),(bX-5*c):PLOT7,(aX+
25*c),(bX+25*c)
800   PLOT7,(aX+5*c),(bX+30*c):PLOT7,(aX-10*c),(bX-10*c):ENDPROC
810   DEFPROCdistance:IF RND(3)=1 FF=2 ELSE FF=1
820   JPX=SQR((aX-XO%)^2+(bX-Y%)^2):IF JPX<500 THEN JJX=JPX/FF ELSE JJX=JPX/2
830   ENDPROC
840   DEFPROCexplosion(XXX,YYY,ZZZ,WWW):IF c<0.7 VDU19,1,15,0,0,0,19,0,11,0,0,
0:JKK=67 ELSE JKK=69
850   FORD=-ZZZ TO 0:IF D>-46 PPX=D/3 ELSE PPX=-15
860    SOUND0,PPX,6,1:T=(150+D)*WWW:PLOTJKK,RND(T)-T/2+XXX,RND(T)-T/2+YYY:NEX
T:VDU19,0,1,0,0,0,19,1,7,0,0,0:ENDPROC
870   DEFPROCextra:QP=(SC DIV 5000)*5000:IF SCORE>=QP ENDPROC ELSE NOLEFT=NOLE
FT+1:VDU7:ENDPROC
880   DEFPROCtest(Q,W,E)
890   PROCdistance:IF JPX<48 PROCdestroy:PROCtest2:PROCastinit:PROCasteroid
900   ENDPROC
910   DEFPROCoff:VDU23,1;0;0;0;0:ENDPROC:REM  Change to VDU23,8202;0;0;0; for
BS 0.1
```

This program is specifically for the BBC model B but could be squeezed into a model A with a few changes: in line 160 change Mode4 to Mode5; in line 170 change the VDU24 to accommodate the new Mode; in line 560 the printing will have to be changed to make it neat; as there are four colours in Mode5 rather than two in Mode4 you can be more adventurous with the colours.

```
                                  * INTERRUPT INTERCEPT *
                                  © Simon Liston 3/1/83
                                  Set Interrupt Mode 2 and
                                  Initialize Interrupt Vector
                                  Table
05040  F3 21 F8 FC 01 10 01 36   ;
05042  F7 23 05 78 B1 20 F8 ED   ;
05055  FD ED 47 ED 5E FB C9 DW   ;
05064  00 00 00 00 00 00 00 00   ;
05475  DD 55 F5 CD D5 D5 3A B2   ;
05487  F8 DD 35 B2 F8 CD 48 D4   ;
05495  3E 02 32 B2 F8 3A B5 F8   ;
05503  A7 20 01 37 3E 85 F8 F8   ;
05511  60 CD 46 F8 AF 32 B5 F8   ;
05519  5A E4 F8 CD C1 D5 21 F8   ;
05527  E4 F8 CD 66 D4 CD 48 D4   ;
05535  32 B4 F8 3A B3 F8 A7 CC   ;
05543  01 27 32 B3 F8 CD 79 D4   ;
05551  46 F8 3E 01 32 B3 F8 DD   ;
05559  21 F8 11 40 00 DD 19 79   ;
05567  F8 3E 0A CD 80 F8 3A B4   ;
05575  F8 CD 79 F8 3E 0A CD 80   ;
05583  F8 DD 21 F8 11 40 00 DD   ;
05591  19 58 06 09 26 07 23 10   ;
05599  FD 21 F8 11 40 00 DD 19   ;
05607  3E 0A CD 80 F8 3E 0A CD   ;
05615  80 F8 CD 9C F8 CD DC F8   ;
05623  CD 9C F8 CD DC F8 ED 5B   ;
05631  36 F8 01 19 FB 1A 13 00   ;
05639  2B 20 29 29 29 19 11 00   ;
05647  01 06 08 7E EE FF DD 77   ;
05655  00 23 DD 19 1F 00 18 30   ;
05663  DD 23 DD 1F 00 18 30 00   ;
05671  00 00 00 00 00 00 00 00   ;
org 50000 (65040)
                                  ** Real Time Clock **
                                  org 54998 (63479)
63479  DD E5                      push ix
63481  F5                         push af
63482  C5                         push bc
63483  D5                         push de
63484  E5                         push hl
63485  3A B2 F8                   ld a,(Real)
63488  3C                         inc a
63489  32 B2 F8                   ld (Real),a
63492  C2 46 F8                   jp nz,Ptime
63495  3E 32                      ld a,50
63497  32 B2 F8                   ld (Real),a
63500  3A B5 F8                   ld a,(Secs)
63503  A7                         and a
63504  CE 01                      adc a,1
63506  27                         daa
63507  32 B5 F8                   ld (Secs),a
63510  D3 50                      cp 50
63512  C2 46 F8                   jp nz,Ptime
63515  AF                         xor a
63516  32 B5 F8                   ld (Secs),a
63519  3A B4 F8                   ld a,(Mins)
63522  A7                         and a
63523  CE 01                      adc a,1
63525  27                         daa
63526  32 B4 F8                   ld (Mins),a
63529  FE 60                      cp 96
63531  C2 46 F8                   jp nz,Ptime
63534  AF                         xor a
63535  32 B4 F8                   ld (Mins),a
63538  3A B3 F8                   ld a,(Hours)
63541  A7                         and a
63542  CE 01                      adc a,1
63544  27                         daa
63545  32 B3 F8                   ld (Hours),a
63548  FE 13                      cp 19
63550  C2 46 F8                   jp nz,Ptime
63553  3E 01                      ld a,1
63555  32 B3 F8                   ld (Hours),a
Ptime
```

(continued on page 131)

Interrupt-intercept

Simon Liston,
Walthamstow,
London.

SPECTRUM

THE ZX SPECTRUM produces an interrupt every 0.02 seconds. The Spectrum ROM uses this interrupt to increment the Frames system variable and also to see if any keys are being pressed. This short machine-code program causes the micro to Call address 63479 on each of these interrupts. I have written a real-time clock to illustrate one possible use of this facility.

First, reserve some memory; type Clear 63400. Next, Poke the 23 bytes of the interrupt-intercept into locations 65040-65062. Now, Poke the machine code for the real-time clock into locations 63479-63665. Check what you have Poked with the listing, then Save the code you have entered. Next, Enter Rand USR 65040.

You should now have a random time displayed in the top right-hand corner of the screen. Hours, minutes and seconds are stored in packed-bed format. Their respective addresses are: 63667, 63668 and 63669.

Setting the time, for example, 11:44:13 is done as follows:

```
POKE 63667, 1*16+1
POKE 63668, 4*16+4
POKE 63669, 1*16+3
```

Note that you must have a self-contained machine-code program at locations 63479-64760, that is, unless you know exactly what you are doing, you should Save all the registers and do not alter any system variables.

It is a good idea to end your routine not with ei; ret but with JP 56_{16}, this causes control to be passed to the usual interrupt routine.

The clock program given will keep good time so long as Load, Save, Beep, Copy or the printer are not used. Some other ideas: on every interrupt, Print the value of the system variable PPC to show you the line number being interpreted. This provides a simple trace mechanism. Or set SCR CT to 255 on every interrrupt, this will stop the Scroll? function being erased. Why not have a delay loop on every interrupt? This will slow down program execution — if it is not slow enough already.

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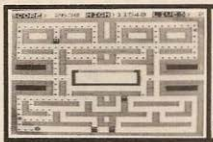

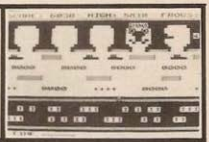

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(continued from page 129)

```
63558 DD 21 18 40   ld ix,16408
63562 3A 83 F8      ld a,(Hours)
63565 CD 79 F8      call Pdec
63568 3E 0A         ld a,10
63570 CD 8C F8      call Pch
63573 3A 84 F8      ld a,(Mins)
63576 CD 79 F8      call Pdec
63579 3E 0A         ld a,10
63581 CD 8C F8      call Pch
63584 3A 85 F8      ld a,(Secs)
63587 CD 79 F8      call Pdec

63590 21 18 58      ld hl,22552
63593 06 08         ld b,8
Ar
63595 36 C7         ld (hl),199
63597 23            inc hl
63598 10 FB         djnz Ar
63600 E1            pop hl
63601 D1            pop de
63602 C1            pop bc
63603 F1            pop af
63604 DD E1         pop ix
63606 C3 38 00      jp 56

Pdec
63609 F5            push af
63610 CB 3F         srl a
63614 CB 3F         srl a
63616 CB 3F         srl a
63618 CD 8C F8      call Pch

63621 F1            pop af
63622 E6 0F         and 15
63624 CD 8C F8      call Pch
63627 C9            ret

Pch
63628 DD E5         push ix
63630 2A 36 5C      ld hl,(23606)
63633 11 80 01      ld de,384
63636 19            add hl,de
63637 EB            ex de,hl
63638 6F            ld l,a
63639 26 00         ld h,0
63641 29            add hl,hl
63642 29            add hl,hl
63643 29            add hl,hl
63644 19            add hl,de

63645 11 00 01      ld de,256
63648 06 08         ld b,8
Ur
63650 7E            ld a,(hl)
63651 EE FF         xor 255
63653 DD 77 00      ld (ix+0),a
63656 23            inc hl
63657 DD 19         add ix,de
63659 10 F8         djnz Ur
63661 DD E1         pop ix
63663 DD 23         inc ix
63665 C9            ret

Real
defb 50
Hours
63667 00            nop
Mins
63668 00            nop
Secs
63669 00            nop
```

Chords

Bernard Dembowski,
Feltham,
Middlesex.

ACE

THREE TYPES of chord are described by this program: major, minor and seventh. Each chord consists of eight notes played in rapid succession, similar to the banjo cross-picking style. A bar — four beats — requires 16 notes. Within the confines of this Forth program, if one chord lasts the length of the bar, you enter it twice. In other words, one chord entry equals two beats.

Now for the program. First enter a variable, T; this is the length of each note in milliseconds. This governs the tempo of your tune. Next, define the word Chord, then define the chords you need for your tune. The Jupiter Ace's memory is not sufficient to store all the chords shown, so just define the chords you need. Unfortunately, this method is not suitable for waltzes, that is, anything in three-four time. In the example the chords are written out exactly as you would enter them into the Ace.

Michael, row the boat ashore
150 T !
D D D D G G D D F# m F# m Em Em D A7 D D

House of the Rising Sun
200 T !
Dm F G Bb Dm F A7 A7 Dm F
G Bb Dm A7 Dm F Dm F G
Bb Dm F A7 A7 Dm F G Bb
Dm A7 Dm Dm

```
100 VARIABLE T
: CHORD 8 0 DO T @ BEEP LOOP ;

( MAJOR )

: C 319 379 239 319 379 239 319 379 CHORD ;

: F 179 358 284 179 358 284 179 358 CHORD ;

: G 319 426 253 319 426 253 319 426 CHORD ;

: D 338 426 284 338 426 284 338 426 CHORD ;

: A 284 379 451 284 379 451 284 379 CHORD ;

: E 301 379 253 301 379 253 301 379 CHORD ;
: D♭ 358 426 268 358 426 268 358 426 CHORD ;
: E♭ 319 402 268 319 402 268 319 402 CHORD ;

: A♭ 301 402 478 301 402 478 301 402 CHORD ;

: D♭ 301 358 451 301 358 451 301 358 CHORD ;

: G♭(F#) 268 338 451 268 338 451 268 338 CHORD ;

: B 253 338 402 253 338 402 253 338 CHORD ;
( MINOR )

: CM 402 319 239 402 319 239 402 319 CHORD ;

: FM 358 301 239 358 301 239 358 301 CHORD ;

: GM 426 319 268 426 319 268 426 319 CHORD ;

: DM 426 358 284 426 358 284 426 358 CHORD ;

: AM 379 284 239 379 284 239 379 284 CHORD ;

: EM 379 319 253 379 319 253 379 319 CHORD ;

: B♭M 358 451 268 358 451 268 358 451 CHORD ;

: E♭M 338 268 402 338 268 402 338 268 CHORD ;

: A♭M 402 301 253 402 301 253 402 301 CHORD ;

: D♭M 379 301 451 379 301 451 379 301 CHORD ;

: G♭M(F#M) 338 284 451 338 284 451 338 284 CHORD ;

: BM 426 338 253 426 338 253 426 338 CHORD ;

( SEVENTH )
: C7 379 319 268 379 319 268 379 319 CHORD ;
: F7 402 358 239 402 358 239 402 358 CHORD ;
: G7 426 358 253 426 358 253 426 358 CHORD ;
: D7 426 338 239 426 338 239 426 338 CHORD ;
: A7 379 319 451 379 319 451 379 319 CHORD ;
: E7 426 379 253 426 379 253 426 379 CHORD ;
: D♭7 358 301 426 358 301 426 358 301 CHORD ;
: E♭7 402 319 451 402 319 451 402 319 CHORD ;
: A♭7 402 338 239 402 338 239 402 338 CHORD ;
: D♭7 358 301 253 358 301 253 358 301 CHORD ;
: G♭7(F#7) 338 379 451 338 379 451 338 379 CHORD ;
: B7 338 284 402 338 284 402 338 284 CHORD ;
```

Stuntman

C Szponjnarowicz,
Hounslow,
Middlesex.

ATOM

STUNTMAN uses high-resolution graphics, and creates realistic motor bike sound effects. The program fits into 2.5K but high-resolution is also needed.

The basic idea is that the motorcyclist has to jump as many buses possible. To acquire the correct speed, press Control to accelerate, Shift to decelerate, and Repeat to jump. The correct speed is equal to the number of buses multiplied by 10.

The exact speed would be too difficult to get, so at the start of the progam the skill level is asked for. Now the speed to successfully jump all the buses is greater than the number of buses, but less than the number of buses combined with the current skill level.

There are two starting roads before the final road, where the correct speed has to be attained. If you travel too fast, the bike crashes into the ramps. If you travel too slowly, the bike will not generate enough speed and will fall killing your man. If you attempt to jump before the third road, the bike crashes, losing one of your three lives.

When the roads have been drawn, and the

(continued on page 133)

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SOFTWARE FILE

(continued from page 131)

bike appears at the top of the screen, press any key to start. This happens each time the bike is positioned at the top left-hand corner of the screen.

The first line, retains the high score — value of H — even if Break has been hit, but set the value to 0 when the program is first loaded.

In some places — for example, 8000-8300 and 9000-9300 the Plot statement has been used instead of Move and Draw. This is for ease in typing. For example once lines 8000-8300 have been typed, it is a simple matter of editing these lines, changing the line number to 9000, 9200 and 9300 and changing the Plot 13 to Plot 15.

Line 8100 does not have to be edited because it is used to delete remnants of the bike before the ramp. This editing can also be used for lines 270 converted to 307 — remembering to delete the Goto variable i.

```
>L.
   1IFH<0 H=0;REM STUNT MAN
   5P.$12"          STUNT MAN"'"   BY C.SZPOJNAROWICZ 1/1/83"'
   6P."THE OBJECT OF THE GAME IS TO "'"JUMP AS MANY BUSES AS"
   7P." POSSIBLE."'"THE CONTROLS ARE"'"  CTRL-ACCELERATE"'
   8P." SHIFT-DECELERATE"'"  RETT-JUMP"'
  10P.'''"SKILL LEVEL"'
  11IN."1 IMPOSSIBLE TO 1000 EASY"'J
  13L=0;S=10;A=150;X=50;Y=30;U=2;I=151;Z=1;V=110;W=30
  14G=-1;K=V-X-40;T=50;N=50;M=30;F=J
 150CLEAR4
 200aF.0=0TO256 S.2;PLOT13,0,(A-1);N.0
 210F.Q=1TO257 S.2;PLOT13,Q,(A-2);N.Q
 220F.Q=0TO256 S.2;PLOT13,Q,(A-3);N.Q
 230A=A-60;IF A>10 G.#;A=30
 250REM DRAW RAMP
 270;PLOT15,V,W;PLOT7,(V-19),(W+10);PLOT7,(V-19),W;PLOT7,V,W
 275V=V+10
 300REM BIKE
 301aPLOT13,X,Y;PLOT5,(X+19),(Y+10);PLOT5,(X+19),Y;PLOT5,X,Y
 302IF T<>100 G.I
 303aS=10*Z;IF U=2;I=151;Z=1;X=50;Y=30
 306PLOT13,X,Y;PLOT5,(X+19),(Y+10);PLOT5,(X+19),Y;PLOT5,X,Y
 307PLOT13,V,W;PLOT5,(V-19),(W+10);PLOT5,(V-19),W;PLOT 5,V,W
 308PLOT13,U,I
 309LI.EFFE3
 310bPLOT15,U,I;U=U+Z;PLOT13,U,I
 312IF I=31 AND U>(X+20) G.d
 313IF I=31 PLOT15,(X-3),(Y+1);PLOT7,(X-1),(Y+1)
 315?£8002=5;?£8003=4
 330IFU>=256 I=I-60
 335IFU>=256 U=0
 340IFZ<1 Z=1
 350IF?£8001&£40=0 Z=Z+1
 360IF?£8002<128 Z=Z-1
 370IF?£8002&£40=0 G.c
 400 G.b
2000cIF I<>31 G.d
2010S=10*Z;K=V-X-40
2030IFU<(X-1) G.b
2040IF?£8002&£40=0 AND U>(X-10) U=X
2050IFU>(X+1) G.d
3000REM JUMP
3020IFS<K G.t
3025IFS>(K+J) G.d
3027G.e
3030IFS<K G.t
3031IFS>(K+J) G.d
3032tPLOT15,U,I;U=U+2;I=I+1;PLOT13,U,I
3033?£8002=5;?£8003=4
3034WAIT;WAIT;WAIT;WAIT;IFU<64+(K/2) G.t
3035PLOT15,U,I;I=I-1;U=U+2;?£8002=5;?£8003=4;PLOT13,U,I
3036WAIT;WAIT;WAIT;WAIT;IF I>41 G.r
3037G.d
3040IF S>(K+J) G.d
3045G.e
3090G.300
5000ePLOT15,U,I;U=U+2;I=I+1
5005PLOT13,U,I
5006WAIT;WAIT
5007?£8002=5;?£8003=4
5008IFU>(X+19)+(K/2) G.f
5010G.e
6000fPLOT15,U,I;U=U+2;I=I-1;PLOT13,U,I
6002?£8002=5;?£8003=4
6003WAIT;WAIT;WAIT
6004IF I>31 G.f
6100I=31
6105PLOT15,U,I;U=U+1;PLOT13,U,I
6110?£8002=5;?£8003=4;WAIT;WAIT
6120IFU<V+20G.6100
6122F=F-(F/3)
6123T=50;Z=1
6127PLOT15,U,I;G.i
6130iG.270
7000uIFK=20 K=0
7005D=(K/10)
7010 P.$12"YOU HAVE KILLED 3 MEN "'"YOU JUMPED"
7050P.D" BUSES"'
7100P."YOUR SCORE WAS"K
7130IFK>H H=K
7140P. '"AT SKILL LEVEL"J
7150P.'"THE HIGH SCORE IS"H
7250IN.'"WOULD YOU LIKE ANOTHER GO "$T.
7300 IF?T.=CH"N" E.
7350IN."WOULD YOU LIKE INSTRUCTIONS "$T.
7360IF?T.=CH"N"G.10
7370G.5
7400E.
8000dPLOT13,(U+2),(I+2);PLOT5,(U-2),(I-2)
8100PLOT15,(U-2),I;PLOT 7,(U+2),I
8200PLOT13,(U-2),(I+2);PLOT5,(U-2) ,(I-2)
8300PLOT13,U,(I+2);PLOT5,U,(I-2)
8350F.G=0TO400;?£8002=0;N.G;Z=1;PLOT15,U,I;L=L+1
8560IF L=3 G.o
9000sPLOT15,(U+2),(I+2);PLOT7,(U-2),(I-2)
9200PLOT15,(U-2),(I+2);PLOT7,(U+2) ,(I-2)
9300PLOT15,U,(I+2);PLOT7,U,(I-2)
9350T=100
9400G.S
9500rPLOT13,(N+21),M;PLOT5,(N+22),M
9510PLOT13,(N+27),M   ;PLOT5,(N+28),M;M=M+1;IF M<32 G.r
9520wPLOT13,(N+21),M;PLOT5,(N+28),M;M=M+1;IF M<48 G.w
9525M=30
9527MOVE(N+22),(M+10);DRAW(N+27),(M+10)
9530PLOT15,(N+23),(M+8);PLOT7,(N+26),(M+8)
9532PLOT15,(N+23),(M+7);PLOT7,(N+26),(M+7)
9533N=N+10
9535G=G+1;IF G<(K/10) G.z
9540G.p
```

Hi-res mover

Jan Erik Lundberg,
Solna,
Sweden.

SPECTRUM

IMPRESSED BY THE SMOOTH action of the hi-res graphics in Psion's Planetoids for the Spectrum I just had to have a go at writing a machine-code subroutine that could do a similar job. I hope that it will be useful for the readers who want to write their own programs using moving graphics.

Overcomplicated Basic programs would be too slow but perhaps a compiled version would be better.

The demonstration driver program is only intended to show how to use the routine and demonstrate its good and bad features.

See what happens when you change the mode — 0 to 3. The subroutine writes or erases the user-defined graphic in high-res — 172×256. You can expand them from 21 to 32. It is position-independent coded, PIC, and you should start to load it 600 bytes lower than the UDG pointer. Perhaps it is easier to load it directly from the memory dump.

```
  1 REM HiRes Mover (c)JEL
  2 CLEAR 31999
  3 POKE 23609,30
  10 RESTORE 30000
  20 FOR a=32000 TO 32038
  30 READ n: POKE a,n
  40 NEXT a
  48 RESTORE 55
  49 FOR a=32041 TO 32066
  50 READ n: POKE a,n
  55 DATA 60,126,126,126,126,60
  56 NEXT a
  60 LET x=23728
  61 LET y=x+21
  62 LET ch=23677
  63 LET mod=ch+1
  70 REM Only 192 bytes
  71 REM ch=int(code-144)
     144<=code<=164 (could be
     extended to max. 31 by
     lowering udg) 80 bytes
  72 REM mo=1 colour change dis-
     table. mo=2 no restoring
  80 LET x=100
  85 LET y=32
  86 BORDER 5: INK 1: PAPER 6
  89 LET xr=1: LET yr=1
  90 PRINT AT 0,0; INK 1;"
  91 PRINT AT 1,0; INK 5;"
  92 FOR i=1 TO 20: PRINT AT i,0
     INK 2;"
     ": NEXT i
  93 FOR i=1 TO 23: PRINT AT RND
     *20+.5,RND*30+.5;"* *": NEXT i
  95 POKE mod,2: REM "eat" mode
  98 POKE ch,2: REM write red *
 100 POKE x,y
 101 POKE x,x
 108 LET i=USR 32000: REM write
 109 IF i=1 THEN PRINT AT 2,20;"
     HIT": BEEP .2,50
 109 IF i=0 THEN PRINT AT 2,20;"
     "
 111 IF INKEY$="5" THEN LET xr=-
     1
 112 IF INKEY$="8" THEN LET xr=1
 113 IF INKEY$="7" THEN LET yr=1
 114 IF INKEY$="6" THEN LET yr=-
     1
 115 LET x=x+xr
 117 LET y=y+yr
 119 LET i=USR 32004: REM erase
 120 GO TO 100
 1000 STOP
 3000 REM finds moverpointer IX
      write erase flag (in af') (clears
      23672 for later use as hit and
      colour change flags
 3010 DATA 175,55,24,1,175,71,8,3
      3,126,90,126,230,7,119,45,126,23
      0,248,79,126,230,7,45,143,87,126
      ,230,248,178,119,221,42,123,92,2
      21,9,17,139,255,221,25
 3050 REM sets attpointer accord
      ing to Y, pushes it on stack AND
      leaves with any mod 192
 3060 DATA 33,224,98,14,32,58,177
      ,92,24,192,40,2,198,192,95,22,0
      ,152,237,66,146,48,251,138,5,229
      ,152
 3100 REM sets picpointer HL acco
      rding to y and leaves D with lin
      es left for, E with 1 if rows
      8 (swarning for bankshift)
 3110 DATA 33,224,87,58,14,64,237
      ,88,146,48,251,199,25,14,32,90,9
      ,29,237,66,146,48,250,138,8,184,
      40,5,21,37,61,32,251
 3150 REM adjust pointers for x
      and push attpointer on stack
      (=rest in x, b=8 lines to scan
 3160 DATA 58,176,92,184,40,12,19
      3,95,3,214,8,48,250,198,8,43,11,
      197,79,6,8
 3300 REM main line scan loop
      writes or erases the dots ,sets
      up the flag register for later
      use in colour part
 3305 REM adjusts all data for re
      st in
 3310 DATA 197,213,229,121,221,70
      ,124,14,0,86,35,94,221,102,132,1
```

(continued on page 135)

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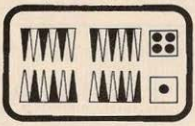

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SOFTWARE FILE

(continued from page 133)

```
95,185,40,15,203,55,203,25,203,6
0,203,89,203,35,203,16,61,32,241
3320 REM  write or erase and set
  up flags
3330 DATA 229,93,126,92,203,94,3
2,12,184,40,2,203,230,105,40,14,
203,238,24,10,184,40,2,203,246,1
85,40,2,203,254,8,48,26,229,12,
6,126,162,40,2,203,214,203,70,40
,2,22,0,221,114,132,225,226,126,
176,119,58,126,47,24,15,8,209,2
5,120,47,79,160,176,119,35,121,
47,79,161,176,119,43,209,193
3400 REM end of main scanning lo
op. Adjusts pointers for  next
byte to be written
3410 DATA 221,43,229,40,5,37,16,1
34,24,229,5,240,28,4,225,16,248
,203,222,225,197,4,254,6,229,40
,2,203,254,203,6,255,3,193,24,224
3500 REM writes the appropriate
 attributes and returns with bc=1
if any hit
3510 DATA 33,141,92,8,48,2,46,14
,6,225,46,128,209,203,36,40,4,12
6,79,24,28,1,223,255,203,102,48
,8,10,19,203,110,40,1,16,235,9,2
5,203,118,40,16,10,19,203,126,48
,1,16,1,0,8,8,56,2,203,150,203,8
6,200,18,203
6000 FOR a=32000 TO 32335 STEP 4
6010 LPRINT a;" ";PEEK a;TAB 12;
PEEK (a+1);TAB 18;PEEK (a+2);TAB
 24;PEEK (a+3)
6020 NEXT a
6030 STOP
9000 LET sum=0
9010 FOR a=32000 TO 32335
9020 LET sum=sum+PEEK a
9030 NEXT a
9040 LPRINT "Checksum =";sum
```

```
32000 175  55  24   1
32004 175  71   8  33
32008 126  92 126 230
32012   7 119  45 126
32016 230 248   7 126
32020 230   7  45 145
32024 87   1 126 230 248
32028 178 119 221  42
32032 183  93 221   9
32036 17  159 255 221
32040 25  93  224  90
32044 14  92  168 177
32048 93  214 192  49
32052 29   8  167 237
32056 22   8  167 237
32060 66  146  46 221
32064 190  9  229 203
32068 33  224  93  89
32072 14  64  237  82
32076 145  46 251 129
32080 25  14  92  20
32084 9   29  237  66
32088 145 46  250 130
32092 9   184  48   5
32096 21  237  67  92
32100 221 95  176  92
32104 184 40   12 199
32108 35   3  214  14
32112 48  250 198   6
32116 40  11  197  79
32120 5   8   197 213
32124 229 121 221  70
32128 124 14   9   86
32132 35  94  221 102
32136 102 105 150  40
32140 15  203  56 203
32144 85  203  86 203
32148 29  203  35 203
32152 10  61   32 241
32156 203 33  126  92
32160 203 94   32  12
32164 184 40   2  203
32168 230 105  40  14
32172 203 236  24  18
32176 184  2   2  203
32180 246 185  40   2
32184 203 254   8  48
32188 28   9  221 126
32192 184 40   8   6
32196 203 214 203  78
32200 40   2  22   0
32204 221 114 132 225
32208 225 126 176 119
32212 58  126 177  24
32216 15   8  209  25
32220 120  47  79 160
32224 175 119  35 121
32228 47  79  161 176
32232 119 43  209 193
32236 221 43   21  48
32240 5   37   16 134
32244 24  28   5  49
32248 25   4  229  33
32252 126 92  203 222
32256 225 197   1 224
32260 6   29   40   4
32264 254 6   193  24
32268 8   255   9 193
32272 34  224  33  41
32276 92   8   48   2
32280 46  143   8 126
32284 46  126 209 203
32288 06  40   4 203
32292 70  32   28   1
32296 223 255 203 102
32300 40   1   16  19
32304 203 110  40   1
32308 16  235   9  235
32312 203 118  40   1
32316 16  19  203 126
32320 40   1   16   1
32324 0   8   56  56
32328 2   8  203 150
32332 86  200  12 201
```

```
Checksum =34753
```

List remedy

Robert Pearlman,
Winchmore Hill,
London.

ZX-81

THE LIST routine provided by Sinclair in the ZX-81 ROM is inadequate for the serious programmer for several reasons: a long program must be listed in small sections using many List statements, which is time-consuming and leads to mistakes; the end of a very long line cannot be listed; after a Newline character in a line, which is common in machine-code programs, the rest of the line and the rest of the program are sometimes not listed. Finally, after a Chr$ 126, a common character in machine-code programs, the next five bytes are not listed.

These faults are remedied by my List routine. When executed, a screenful of text is scrolled up the screen and displayed. A small black square then appears in the bottom left of the screen indicating that the program is waiting for a key to be pressed, either Break to abort the listing, or any other key to continue.

The machine-code routine occupies 160 bytes and may be located anywhere in RAM because it uses no absolute addressing, a good place being in RAMtop or in a Rem statement. It can be entered using any of the hexadecimal loaders that have been in previous issues of *Your Computer*. It is executed by Rand Usr followed by the start address.

```
ZX81 machine code list
start
add.+ hex          mnemonic      comment
0000 1615          LD D,21
0002 D5            PUSH DE
0003 010014        LD BC,3120
0006 CDF50B        CALL 2293     !print at b,c (20,0)
0009 217D40        LD HL,16509   !beginning of program
000C 46            NL:LD B,(HL)
000D 23            INC HL
000E 4E            LD C,(HL)
000F CD9B0A        CALL 2712     !print line no.
0012 E1            POP DE
0013 1E16          LD E,22
0015 D5            PUSH DE
0016 23            INC HL
0017 46            LD B,(HL)
0018 05            DEC B         !b is length of line -1
0019 23            INC HL
001A 23            INC HL
001B AF            XOR A
001C 20EE          NEWLINE:JR NZ, NL
001E 7E            START:LD A, (HL)
001F FE7E          CP 126
0021 2009          JR NZ, NOT.126
0023 78            LD A,B
0024 010500        LD BC,5
0027 09            ADD HL,BC     !jump over 5 bytes of data
0028 91            SUB A,C
0029 47            LD B,A
002A 180C          JR SKIP
002C CB77          NOT.126:BIT 6,A   !see if chr$(a) is printable
002E F5            PUSH AF       !preserve carry flag
002F C5            PUSH BC
0030 C44B09        CALL NZ, 2379 !expands chr$(a)
0033 C1            POP BC
0034 F1            POP AF
0035 CC1000        CALL Z, 16    !prints chr$(a)
0038 23            SKIP:INC HL
0039 3A2A40        LD A,(16442)
003C FE03          CP 3
003E 2051          JR NZ, NOSCROLL
0040 D1            POP DE
0041 15            DEC D
0042 1D            DEC E
0043 AF            XOR A
0044 BA            CP D          !see if a pause is needed
0045 2003          JR NZ, MISS
0047 53            LD D,E
0048 1E22          LD E,34
004A D5            MISS:PUSH DE
004B C5            PUSH BC
004C E5            PUSH HL
004D 201E          JR NZ, NOPAUSE
004F 2A0C40        LD HL,(16396)
0052 11F802        LD DE,760
0055 19            ADD HL,DE     !address for 23,0
0056 E5            PUSH HL
0057 3680          LD (HL),128   !print an inverse space
005A 2A2540        PAUSE:LD HL,(16421) !last key
005C 117FFD        LD DE,64895   !code for 'break'
005F A7            AND A
0060 ED52          SBC HL,DE
0062 19            ADD HL,DE     !cp hl,de
0063 CC0800        CALL Z,8      !if break pressed then
0066 0E            DEFB 12       !output error code D
0067 24            INC H
0068 28EF          JR Z, PAUSE   !halt program until key pressed
006A E1            POP HL
006B 3600          LD (HL),0
006D 2A0C40        NOPAUSE:LD HL,(16396)
0070 E5            PUSH HL
0071 112100        LD DE,33
0074 19            ADD HL,DE
0075 D1            POP DE
0076 01B502        LD BC,693
0079 EDB0          LDIR          !scroll a line
007B AF            XOR A
007C 0620          LD B,32
007E 13            LOOP:INC DE
007F 12            LD (DE),A
0080 10FC          DJNZ LOOP
0082 3A5940        LD A,(16441)
0085 4F            LD C,A
0086 3E21          LD A,33
0088 91            SUB A,C
0089 4F            LD C,A
008A 0A18          LD B,20
008C CDF50B        CALL 2293     !print at 20,c
008F E1            POP HL
0090 C1            POP BC
0091 10BB          NOSCROLL:DJNZ START
0093 3E76          LD A,118
0095 D7            RST 16
0096 23            INC HL
0097 7E            LD A,(HL)
0098 FE76          CP 118
009A 20B0          JR NZ,NEWLINE !if end of program then return to BASIC
009C D1            POP DE
009D C9            RET
```

Sprite write

Keith Berry,
Birmingham.

ATARI

THIS PROGRAM is a utility for redesigning characters or players — sprites — without the need for graph paper.

```
100 REM PLAYER/CHARACTER DESIGN UTILITY
110 REM (c)  Keith Berry 1982
120 DIM R$(15):R$="PRESS  RETURN "
130 MARSET=480:CHST=710:GR=650:GR=370:C
LS=5480:LM=82:MH=12:BLU=112:C1=17:C2=21:C3
=3:C6=61:C16=16:20=0
140 LKP=764:CUR=752:CR0=708:CR1=709:CR2=
710:GRA=7168GRAPHICS 20:POKE CR2,BLU:POK
E CR1,MH:POKE CUR,C1:POKE LM,C2
150 CS=125:BM=255:? "BINARY REPRESENTATI
ON OF DECIMAL NOS.";? ,"(C) K. Berry 198
2."
160 POSITION 8,11:? "DO YOU WANT INSTRUC
TIONS?"
170 Z=PEEK(LKP):IF Z=BM THEN 170
180 POKE LKP,BM:IF Z=35 THEN GOTO GR
190 GRAPHICS 20:POKE CR1,C2:POKE CR2,MH1
:POKE CUR,CT
200 ? :? "Players for PLAYER-MISSILE GRA
PHICS or characters in a redefined charac
ter  set are constructed in rows of"
210 ? "BYTES each 8 bits wide.  Each bit
 is  turned on or not according to the n
o. that the byte holds."
270 ?
```

(continued on next page)

(continued from previous page)

```
280 ? "Designs can be planned on graph p
aper,adding each bit to obtain the decim
al"
290 ? "number for each byte, but Mode 2
of  this program saves you this trouble
.";?
300 ? "Mode 1 allows you to enter decima
l   data and see the resulting characte
r.
310 ? "In the case of a Player, you can
see  the effects of increasing its width
 to";
320 ? "to double or quadruple size as al
lowedby Player-Missile Graphics."
330 ?
340 ? ,R$;
350 Z=PEEK(LKP):IF Z<>HHI THEN 350
360 POKE LKP,BM
370 GRAPHICS 20:POKE CR2,BLU:POKE CR1,HH
I:POKE CUR,C1:POKE LM,C2
380 ? !? "DESIGNING PLAYERS/CHARACTERS":
? "IN BINARY DIGITS."
390 ? !? !? "SELECT:"!? !? "E1 DESIGN F
ROM DATA"!? !? "E2 DATA FROM DESIGN"
400 Z=PEEK(LKP):IF Z<>30 AND Z<>31 THEN
400
410 POKE LKP,BM:IF Z=30 THEN GOTO GR3
420 ? CHR$(CS);"HOW MANY LINES";:INPUT L
430 ? CHR$(CS)
440 ? "ENTER ";L;" NUMBERS (0 TO 255)";?
 !
450 DIM X(L)
460 FOR A=C1 TO L:? A;": ";:INPUT B:X(A)
=B:NEXT A
470 ? !? "WIDTH (1,2 or 4)";:INPUT R:IF
R<C1 OR R>2 AND R<>4 THEN 470
480 POKE LM,15-R*C3
490 GRAPHICS 20:POKE CR1,C2:POKE CR2,HHI
:POKE CUR,C1:?
500 FOR A=C1 TO L
510 H=X(A):A=X(A)
520 Z=128:C=20
530 C=C+C1:IF C=9 THEN GOTO 560
539 REM THE % IN THE NEXT LINE IS AN INV
ERSE SPACE!
540 IF H>=Z THEN FOR P=C1 TO R:? "%";:NE
XT P:H=H-Z:Z=Z/C2:GOTO 530
550 FOR P=C1 TO R:?." ";:NEXT P:Z=Z/C2:G
OTO 530
560 ? " ";N
570 NEXT A:?
580 ? "CHANGE WIDTH (1,2 or 4)"
590 Z=PEEK(LKP):IF Z<>24 AND Z<>30 AND Z
<>31 THEN 590
600 POKE LKP,BM:IF Z=31 THEN R=C1
610 IF Z=30 THEN R=C2
620 IF Z=26 THEN R=C3
630 IF Z=24 THEN R=4
640 GOTO MARSET
650 GRAPHICS C3:POKE CR0,22:POKE CR1,HHI
:POKE CR2,BLU:POKE CR4,200
660 COLOR C1:PLOT 15,20:DRAWTO 24,20:DRA
WTO 24,17:DRAWTO 15,17:DRAWTO 15,20
670 COLOR C2:FOR A=C1 TO 16:PLOT 16,A:DR
AWTO 23,A:NEXT A
680 POKE LM,C1:? "DRAW YOUR DESIGN IN TH
E SPACE, USING  ARROWS,  SPACE ,  DELETE
 & RETURN."
690 POKE CUR,C1:? "(No Shifts needed). W
HEN YOUR DESIGN IS COMPLETE, PRESS  STAR
T  FOR READOUT."
700 X=16:Y=C1
710 IF PEEK(53279)=C6 THEN GOTO CLS
720 Z=PEEK(LKP):IF Z<>C6 AND Z<>7 AND Z<
14 AND Z<>15 AND Z<>HHI AND Z<>33 AND Z
<>52 THEN GOTO CHST
730 POKE 53279,20
740 IF Z=HHI THEN X=16:Y=V+1:IF Y>16 THE
N Y=16
750 IF Z=C6 THEN X=X-C1:IF X<C16 THEN X=
C16
760 IF Z=7 THEN X=X+C1:IF X>23 THEN X=23
770 IF Z=14 THEN Y=Y-C1:IF Y<C1 THEN Y=C
1
780 IF Z=15 THEN Y=Y+C1:IF Y>16 THEN Y=1
6
790 IF Z=33 THEN COLOR C3:PLOT X,Y
800 IF Z=52 THEN COLOR C2:PLOT X,Y
810 FOR H=C1 TO 20:NEXT H
820 IF PEEK(53279)=6 THEN GOTO CLS
830 POKE LKP,BM:GOTO CHST
840 ? CHR$(CS)
850 DIM X(16)
860 J=128:K=C16
870 FOR A=C1 TO 16:X(A)=20:J=128
880 FOR K=C16 TO 23
890 LOCATE K,A,P:IF P=C3 THEN X(A)=X(A)+
J:J=J/C2
900 IF P=C2 THEN J=J/C2
910 NEXT K
920 NEXT A
930 ? "THE DATA FOR THIS DESIGN:"
940 FOR A=C1 TO 16:? X(A);",";:NEXT A:?
 ?
950 ? R$;
960 Z=PEEK(LKP):IF Z<>HHI THEN 960
970 POKE LKP,BM:R=C1:L=16:GRAPHICS 20:PO
KE CR1,C2:POKE CR2,HHI:GOTO MARSET
```

Auto-list

S M Russell,
Lee,
London.

BBC

IT IS SOMETIMES useful to list part of a program automatically under the control of that program. For example, a program could give the option of changing the contents of its Data statements, and then list the relevant lines for alteration. Unfortunately, BBC Basic does not allow the use of the List command within a program. These subroutines overcome the problem.

ProcList scans the program in memory and, when it finds the required lines, sends each line number, its position in memory, and the line length to ProcDecode. ProcDecode first prints the line number, and then sends each byte of the line to a resident routine — located at &B53A — to be translated into a keyword if a token, or into ASCII if not. The result is then printed.

There is one limitation that ProcDecode does not translate the line numbers associated with Goto and Gosub correctly, because these use a special code.

When calling ProcList, the two parameters in brackets after the procedure name specify the first and last lines to be listed. If only one line is required, then set both parameters to that value. Line 10020 gives a demonstration.

These procedures may also be used in error-trapping routines, to display the offending line automatically; for example:

```
10 ON ERROR GOTO 10035
10035 MODE 7:REPORT:PRINT:PROClist
      (ERL,ERL):END
```

```
10000 REM SUBROUTINE TO LIST FROM WITHIN A PROGRAM (C) S.M.Russell 1983
10010 REM DEMO
10020 PROClist(10040,10120)
10030 END
10040 DEF PROClist(n1,n2)
10050 LOCAL length%,line_no%,start%
10060 start%=PAGE:@%=5
10070 REPEAT
10080   line_no%=start%?1*256+start%?2:length%=start%?3
10090   IF line_no%>=n1 AND line_no%<=n2 THEN PROCdecode(line_no%,start%,length%
)
10100   start%=start%+length%
10110   UNTIL start%?1=&FF:@%=&A0A
10120 ENDPROC
10130 DEF PROCdecode(line_no%,start%,length%)
10140 LOCAL A%,I%
10150 DECODE=&B53A:I%=4
10160 PRINTline_no%;
10170 REPEAT:A%=start%?I%:CALL DECODE
10180   I%=I%+1:UNTIL I%=length%:PRINT
10190 ENDPROC
```

Status

Colin Carruthers,
Edinburgh.

SPECTRUM

THIS PROGRAM was written on a 16K machine and will run in either 16K or 48K. It is a short three-line program which I called Status. When executed it returns a number of useful pieces of information about the general status of the machine — program size, variable space and free space. I use it while developing other programs.

```
  1 DEF FN p(n)=PEEK n+256*PEEK
 (n+1)
9998 CLS : DRAW 255,0: DRAW 0,17
5: DRAW -255,0: DRAW 0,-175: PLO
T 40,158: DRAW 127,0: PRINT AT 1
,5;"Machine Status..";AT 4,2;"To
tal RAM      :";(FN p(23732)-163
83)/1024;" K";AT 6,2;"Microdrive
 Maps:";FN p(23631)-23734;" byte
s";AT 8,2;"BASIC Program
 :";FN p(23627)-FN p(23638);" by
tes";AT 9,2;"Variables
 :";FN p(23641)-FN p(23627)-1;" bytes
";AT 11,2;"Free Space
 :";FN p(23730)-FN p(23641);" bytes";AT
 19,2;"UDG:ABCDEFGHIJKLMNOPQRSTU
"
9999 PRINT AT 14,2;"Up Time
 :";INT ((FN p(23672)+65536*PE
EK 23674)/50);" seconds": GO TO
9999
```

```
Machine Status..

Total RAM        :49 K
Microdrive Maps:0 bytes
BASIC program    :3977 bytes
Variables        :73 bytes
Free Space       :36024 bytes
Up Time          :189 seconds

UDG:AB◆◆EFG♥IJKLMNOPQR▗▘U
```

The wall

Robert O'Donnell,
Stockport,
Cheshire.

ZX-81

THE OBJECT of the game, which takes under 16K of RAM, is to catch 10 of the apples that are being thrown over the orchard wall. You steer the basket at the bottom of the screen using keys 5 and 8.

```
  10 FOR I=1 TO 10
  20 PRINT "";
  30 NEXT I
  40 FOR I=1 TO 34
  50 PRINT "";
  60 NEXT I
  61 POKE 16418,4
  62 PRINT "SCORE 0"
  70 LET BAT=16
  80 LET A$="";
  90 LET B$="";
 100 LET SCORE=0
 120 LET APPLES=0
 130 GOSUB 2030
 140 GOSUB 9000
1000 PRINT AT 20,BAT,A$;AT 21,BA
T;B$
1010 LET BAT=BAT+(INKEY$="8")-(I
NKEY$="5")
1020 LET BAT=BAT-(BAT=27)+(BAT=-
1)
1030 RETURN
2000 LET APPLEY=APPLEY+1
2010 IF APPLEY<20 THEN RETURN
2020 IF APPLEX=BAT+3 OR APPLEX=B
AT+2 THEN LET SCORE=SCORE+1
2030 LET APPLEX=INT (RND*28+2)
2040 LET APPLEY=5
2045 PRINT AT 22,5;SCORE
2047 IF SCORE=10 THEN GOTO 9500
2048 LET APPLES=APPLES+1
2049 PRINT AT 22,15;"NUMBER: ";A
PLES
2050 RETURN
3000 PRINT AT APPLEY,APPLEX;"";
3010 GOSUB 2000
3020 PRINT AT APPLEY,APPLEX;"";
3030 RETURN
9000 GOSUB 1000
9010 GOSUB 3000
9020 GOTO 9000
9500 LET A$="WELL DONE, YOU HAVE
 CAUGHT TEN!"
9510 FOR I=1 TO 32
9520 FOR J=0 TO 4
9530 PRINT AT J,I-1;A$(I)
9540 NEXT J
9550 NEXT I
9560 LET A$=" HOWEVER YOU WASTED
 "+STR$ (APPLES-10)+" APPLES "
9570 DIM B$(LEN A$)
9580 LET X=15-LEN A$/2
9590 PRINT AT 11,X;B$;AT 13,X;B$
;AT 12,X;A$
9600 PRINT AT 22,0;"PRESS NEWLIN
E FOR ANOTHER GAME."
9610 PRINT AT 22,0;"PRESS NEWLIN
E FOR ANOTHER GAME."
9620 IF INKEY$="" THEN GOTO 9600
9630 CLS
9640 RUN
```

From the screen

Nigel Beasley,
Exeter,
Devon.

BBC

THIS PROGRAM is an assembly language program for a Model B BBC Micro with a printer interface and Epson MX-80 F/T 3 printer or similar. The final routine occupies about 250 bytes and is located at 10000 in the memory. Alterations may have to be made for other printers. This program takes about two minutes to print the entire screen, much faster than any Basic program.

In this way, graphics and text can be reproduced at the same time.

To use the program, type it in exactly as shown, leaving out any comments, if you wish. Comments follow an oblique sign. Run the program. If you are sure that no errors have occurred then type:

*SAVE"DUMP" 2710 2803 (Return)

This saves the area of memory where the program occurs. Also save the assembly language program as usual:

SAVE"ASSEMBL" (Return)

To use the routine in your programs simply use the Basic command:

CALL 10000

10000 is the memory location where the routine starts. When using the program it must be ensured that you do not overwrite it with a Basic program: Top must be below 10000. To reload the routine into memory having saved it under a particular filename use the command

*LOAD"DUMP" 2710

When reloading the program it will not disrupt any program already in memory, so it can be loaded into memory from a Basic program, using the aforementioned command.

To use with another printer: it must be a dot-matrix printer with bit image printing capabilities. The areas where specific commands for the Epson are shown and the commands for your printer can be inserted here.

```
 10 REM Assembly language program to dump screen onto printer
 20 REM For EPSON MX-80 F/T 3
 30 REM (c) N.Beasley 23/1/83
 40 CLS
 50 OSWORD=&FFF1
 60 OSWRCH=&FFEE
 70 PX=10000: REM Sets program counter **DO NOT CHANGE !!!**
 80 [
 90 LDA £2:JSR OSWRCH \ Turns on printer
100 LDA £1:JSR OSWRCH \ Sets the line spacing to 1/32 inch
110 LDA £27:JSR OSWRCH \ on an Epson
120 LDA £1:JSR OSWRCH
130 LDA £51:JSR OSWRCH
140 LDA £1:JSR OSWRCH
150 LDA £24:JSR OSWRCH
160 LDA £&1F \ Initialises Y value
170 STA &77
180 LDA £4
190 STA &78
200 CLC \ Start of main loop
210 LDA &77 \ Subtracts 32 from Y value
220 SBC £31
230 STA &77
240 LDA &78
250 SBC £0
260 STA &78
270 LDA £1:JSR OSWRCH \ Puts the Epson printer into
280 LDA £27:JSR OSWRCH \ 'Bit image printing' mode
290 LDA £1:JSR OSWRCH
300 LDA £76:JSR OSWRCH
310 LDA £1:JSR OSWRCH
320 LDA £128:JSR OSWRCH
330 LDA £1:JSR OSWRCH
340 LDA £2:JSR OSWRCH
350 LDA £&FF \ Initialses X value
360 STA &70
370 LDA £&FF
380 STA &71
390 .XCOOD \ Start of Xcood loop
400 CLC
410 LDA &70 \ Adds 2 to X value
420 ADC £2
430 STA &70
440 LDA &71
450 ADC £0
460 STA &71
470 LDA £252 \ Initiases Y movement value
480 STA &75
490 LDA £0 \ Initialises memory loacation to receive 'bit image'
500 STA &79
510 .YCOORD \ Start of search
520 CLC
530 LDA &75 \ Adds 2 to Y search value
540 ADC £4
550 STA &75
560 LDA &77 \ Put actual Ycood value into position ready for call
570 SBC &75
580 STA &72
590 LDA &78
600 SBC £0
610 STA &73
620 LDA£9 \ Sets A=9 for OSWORD call
630 LDX £&70 \ Points to locaton of memory where coords are held
640 LDY £0
650 JSR OSWORD
660 CLC
670 LDA &79 \ Takes present 'Bit image'
680 ROL A \ Rotates it left
690 ADC &74 \ Adds result of OSWORD call
700 STA &79 \ Stores result
710 LDA £27 \ Branches back if not finished
720 CMP &75
730 BPL YCOORD
740 LDA £1:JSR OSWRCH \ Sends result to printer
750 LDA &79:JSR OSWRCH
760 LDA £&FF \ Branches back to increase X value if not 1279
770 CMP &77
780 BNE XCOOD
790 LDA £4
800 CMP &71
810 BNE XCOOD
820 LDA £1:JSR OSWRCH \ Sends linefeed to printer
830 LDA £10:JSR OSWRCH
840 LDA &78 \ Branches back to decrease Y value if not 0
850 BNE &2B00
860 LDA £31
870 CMP &77
880 BNE &2B00
890 LDA £3 \ Turns off printer
900 JSR OSWRCH
910 RTS
920 ]
930 PX=&2800
940 [
950 JMP &273B
960 ]
```

Decimal liner

K W Hall,
Catterick Garrison,
North Yorkshire.

VIC-20

THIS USEFUL subroutine was written for the Vic-20 but can easily be modified for other micros. Anyone who writes programs and requires their outputs listed in columns will know that Basic does not line up decimal points. The following subroutine does just that. The subroutine expects the variables to be processed in X: the output is in X$.

```
8000 A$=RIGHT$("      "+STR$(INT(X)),4)
8030 B$=LEFT$(MID$(STR$(INT((X-INT(X))
     *100+.005))+"00",2),2)
8040 C$=".":X$=A$+C$+B$:RETURN
```

X string can now be Printed in a normal For loop Print routine. The spaces in line 8000 can be increased to adjust the position of the output on the screen. ■

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COMPETITION CORNER

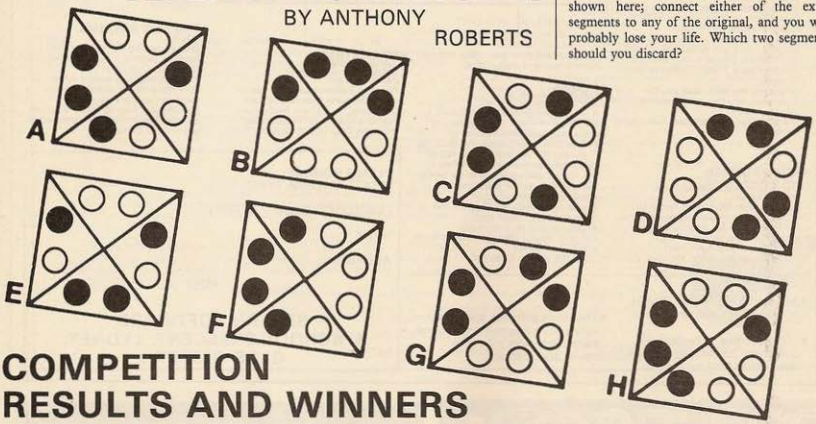
A £15 book token will be awarded to the first correct solution drawn from the competition bag. All entries must be at the *Your Computer* offices by the last working day in March. The name of the winner, the solution, and a competition report will be published in the May, 1983 issue of *Your Computer.*

If you want to set a competition for Competition Corner, remember that the simplest solution should be calculable by a short program rather than by any other form of reckoning.

TELEPATHIC DANGERS

BY ANTHONY ROBERTS

YOU HAVE found the fabulous cube of On'ey! However, as you approach, a careless thought triggers a circuit, and the cube tumbles apart into six regular square-based pyramids, and you know that you have just minutes to reconstruct it before the segments crumble to dust. Each segment connects to its neighbouring segments via a set of four lugs and four holes, two to each triangular face — each lug must match a hole on the next segment. As you gather the segments you notice that there are in fact the eight segments shown here; connect either of the extra segments to any of the original, and you will probably lose your life. Which two segments should you discard?



COMPETITION RESULTS AND WINNERS

JANUARY'S COMPETITION to win an Oric asked contestants to complete the crossword and the sentence, "My New Year should start with an Oric because . . .". If the number of entries for our competitions is any indication of how popular a new computer will be, the Oric should do well; but not as well perhaps as its closest rival, the Spectrum, which drew several hundred more entries last July.

The winning entry was a rather off-beat one from J Elliot, 1 Saint Mary's Road, Burgess Hill, West Sussex, who wrote "I got those ZX-81 — 16K — RAM-pack — wobble blues!". Unlike the ZX-81 the Oric, of course, keeps its memory tucked away inside the case. The ZX-81 also came in for a bit of stick from R Booth who said that "the Alsatian keeps mistaking my ZX-81 for a dog biscuit".

Quite a few readers showed their learning by making a play on the line from Hamlet, "Alas poor Yorick. . .". The best of these was P Douthwaite's "Alas poor Oric, I'd use him well, a computer of infinite jest". This is the one quote, incidentally, that everyone gets wrong. Look up your Hamlet and you will see that Hamlet says not, "I knew him well" but "I knew him Horatio". Neither version, however, is particularly relevant to the Oric.

N Dickason claimed optimistically that "with my Oric promotion will be meteoric", while S Yeo revealed "my wife has run off with the Sinclair". From A Cutler came "it would provide the Basic necessities for life . . . and many other games".

Finally, G Towner's entry raised the big question hanging over Oric International — can it deliver? He pointed out that his New year should start with an Oric because "it will be over 28 days since I ordered one".

A number of correct solutions were sent in for the Star Stone competition but few were accompanied by a program. Admittedly the problem did not lend itself to a short program solution. To find the answer you needed to work out that there are only three faces on the Stella Octangular which cannot form part of a closed loop. Between them they contain one tetrahedroid crystal, three pan-metallic hypercubes and five spheroid diamonds.

The £15 book token goes to the first correct entry picked from the bag which was from P Carlotti, Hope Paint House, Granville Road, Kingsdown, Deal, Kent. ■

The solution to January's crossword when a prize of an Oric 1 was at stake. Although swarms of aspiring Oric owners came forward, the level of entries failed to match last July's competition with its prize of a Spectrum.

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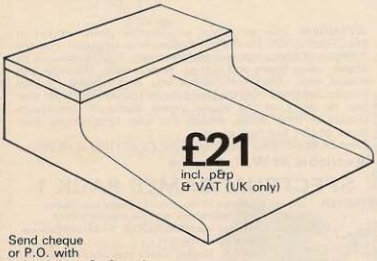

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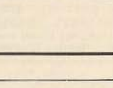

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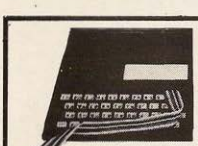

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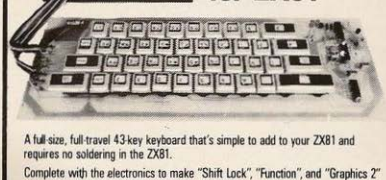

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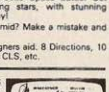

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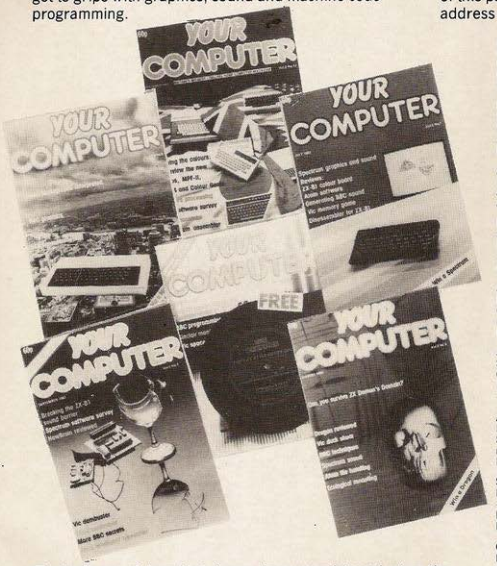

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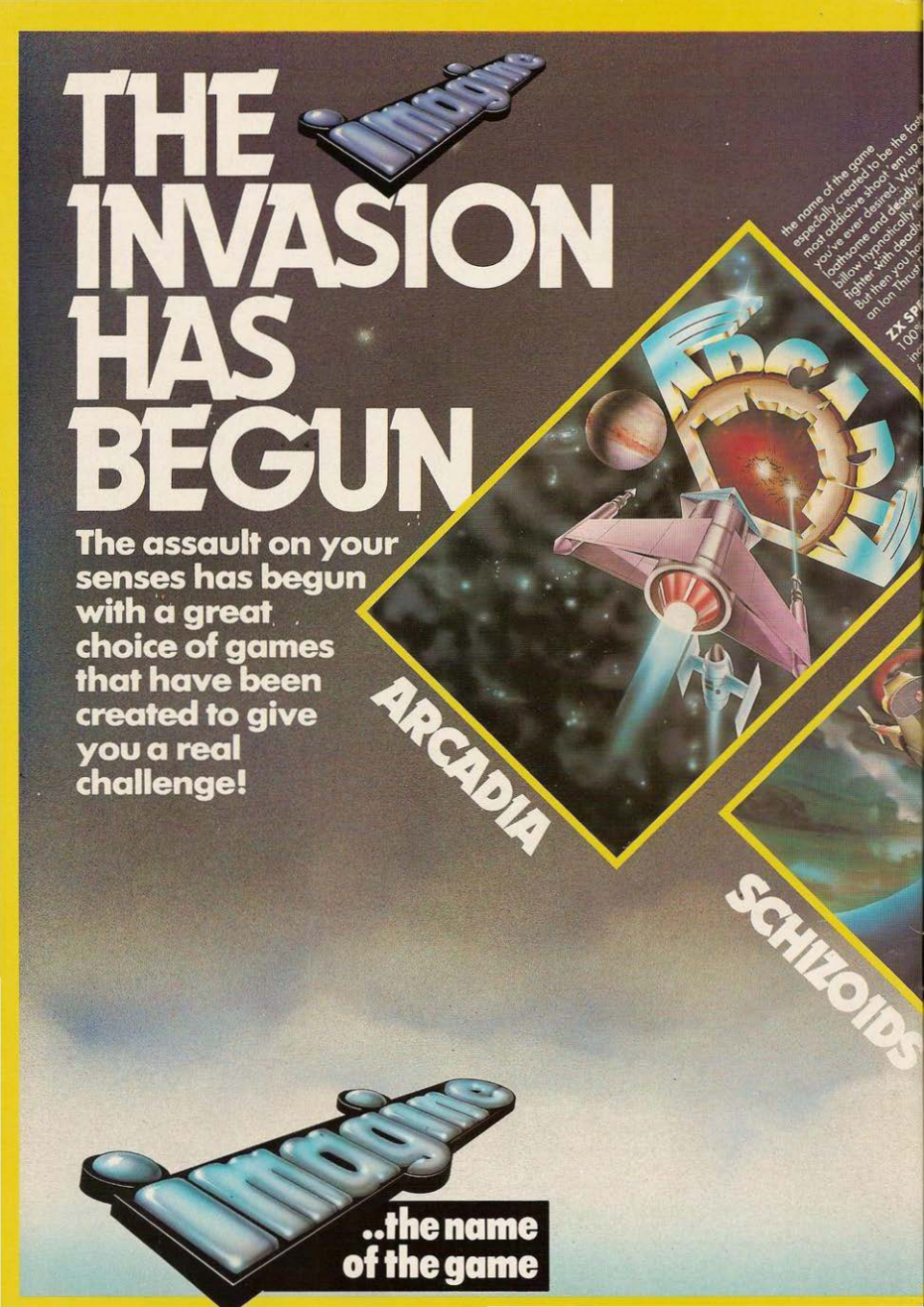
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I thought that with the space-dozer and its shovel and skyhook
Chicks pray. HUH! They warned me of the weird packaging.
But they didn't say I'd have to stop and control not just one but two
the trays, the rods, and all the rest.
But they didn't say I'd have to stop and control not just one but two
or even more garbage pods. Then prod them, push
them toward that black hole, and oh, it's so very, very
black, and so lonely, so empty.
Panic, mustn't panic, but they won't stop, twirling and
spinning and turning, always turning, towards me, against
me, at me. And I'm alone. Nowhere to hide, on my own, my own, own.
No way out, nowhere to hide, on my own, my own, own.
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SCHIZOIDS features real-time animated 3d graphics for a
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or you dodge the drunks and
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AH DIDDUMS features multiple toyboxes with progressive difficulty levels, super rule – super detailed animation, sound and those fast smooth graphics that only IMAGINE can produce. 100% machine code.
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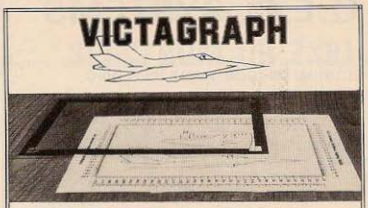

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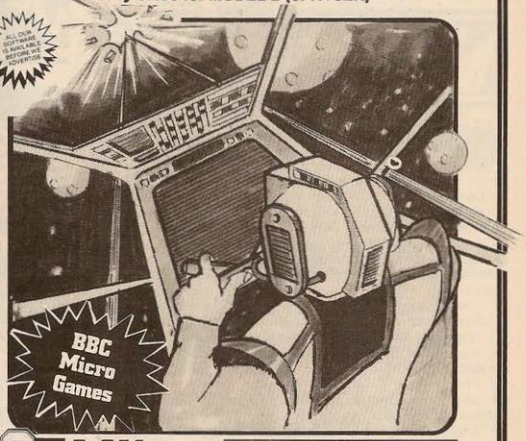

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Dragon 32k or 64k	●				●			●	
VIC20 16k +	●	●	●	●				●	●
Sinclair ZX81 16k +	●								
Grundy NewBrain	●								
Texas TI99 4A	●								
Osborne 1	●								
Sharp MZ80A	●	●	●	●				●	●
Sharp MZ80K	●	●	●	●				●	●
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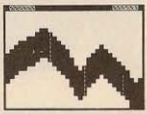

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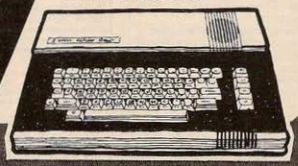

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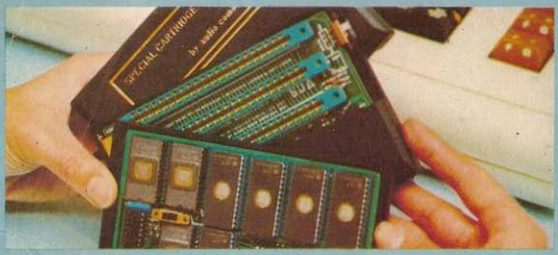

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